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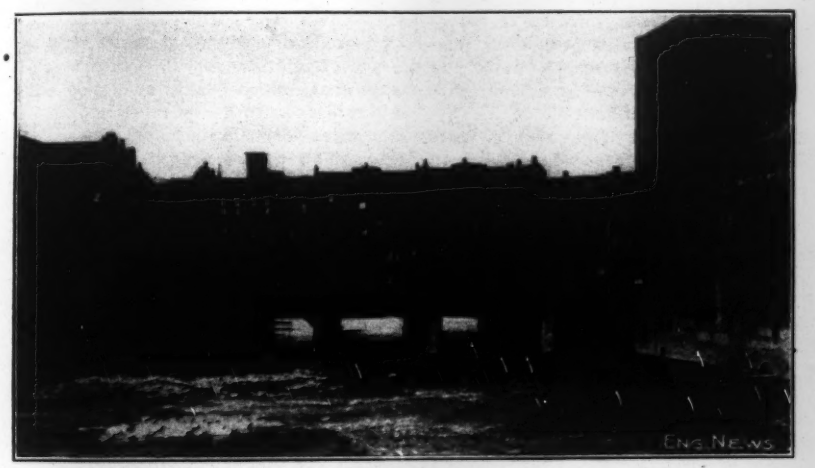
An American Bridge Surmounted by Buildings

By Emile Low*

The front page of Engineering News of May 9, 1912, shows an English bridge surmounted by buildings. As a companion picture there is shown in the accompanying cut an American bridge which is also surmounted by buildings. It is located at Rochester, N. Y., and carries Main Street over the Genesee River.



Bridge over the Genesee River at Main St., Rochester, N. Y.

The following information concerning this bridge was furnished to the writer by Edwin A. Fisher, M. Am. Soc. C. E., City Engineer of Rochester, compiled by William M. Rebasz, Chief Draftsman of Mr. Fisher's office.

A resolution adopted by the Rochester Common Council, under date of May 10, 1855, recommended the building of a stone arch bridge over the Genesee River, at the junction of Main and Buffalo Sts., in accordance with plans and specifications designed and prepared by Daniel Marsh, C. E.

The original design called for a bridge 70 ft. wide, which width was changed later for a bridge covering the full width of Main St., or 99 ft. The bridge is built of cut stone originally intended for the United States government piers at Charlotte, at the mouth of the Genesee River. There being no appropriation for the building of the piers, the City of Rochester bought the stone for about $6000.

Work on the structure was begun in 1856. After the piers were finished the work was delayed, owing to some controversy between the commission in charge of construction and the Common Council. Later, however, work was resumed and the bridge was completed in 1857, at a cost of $60,000.

The engineer in charge of construction was Josiah W. Bissell, and the contractor Chas. B. Coleman.

About the year 1860, the east and west piers were extended southward along the bed of the river, to support buildings. After the close of the war in 1865 the remaining piers were extended, and buildings were rapidly erected, closing in both sides of the bridge, which condition exists at the present time.

The bridge consists of five arches, two of 30 ft. span at the springing line, and three of 42 ft. span, and four piers, each 14½ ft. high, 8 ft. thick at the base and 6½ ft. at the springing line of the arch.

*606 Ashland Ave., Buffalo, N. Y.

Reminiscences of the Pioneer Engineers of the Santa Fe Ry.

By C. L. Annan*

The young graduates who sought work as civil engineer in Massachusetts 35 years ago found little opportunity for the display of their technical ability near home. Within a year or two after leaving school many of them drifted West and into the employ of the great railway companies which were then making every effort to push through to the Pacific coast.

In November, 1878, I bade good-bye to Boston and set forth for Pueblo, Colo. There I found A. A. Robinson, Chief Engineer of the Atchison, Topeka & Santa Fé Ry., who nine years before had begun his railway career as an axeman on the St. Joseph & Denver City R.R. Mr. Robinson was a man of broad outlook, considerate and approachable. He told me I had arrived opportunely, and at once dashed off a letter—the day of the typewriter was not yet come—and handed it to me with instructions to start for the mountains.

The end of track was then at Cañon City, not far from the mouth of the Royal Gorge. It was a narrow-gage road built by the Denver & Rio Grande R.R. Both the D. & R. G. and the Santa Fé had fought for the right-of-way through the Gorge with many war-like preliminaries and show of forces, though not much bloodshed. At this time the Santa Fé had just effected a lease of the D. & R. G. and was to proceed with the construction to Leadville, Colo. The bloodshed and the victory of the D. & R. G. were to come a little later.

Leadville at that period was the most rapidly growing mining center in the world. An almost continuous stream of freighting outfits, two wagons coupled together, drawn by ten mules, was pulverizing the hundred miles of rough road which led from the end of track to the great carbonate camp. The bottoms of the steep rises were marked by the

*2129 Scudder St., St. Paul, Minn.

carcasses of unfortunate mules, and an impalpable alkali dust constantly clouded the air.

Thirty miles below Leadville I came up with Henry R. Holbrook, the engineer in charge of that division. He was a medium-sized man in short top boots and a soft felt hat, which never sat twice on his head in the same way, and with a roll of manila paper ever under his arm. He knew just where to put his line, but only after the most thorough investigation. He always looked closely after details and insisted on nice work. A few years later as Chief Engineer of the Atlantic & Pacific Ry., he specified ¼-in. joints for the masonry foundations of the famous Cañon Diablo bridge.

Holbrook was a man of very few words, although he was never grim. He had a kindly far-away expression and was greatly respected. Much absorbed in his work, he gave little thought to personal comfort; and, incidentally, the provision for his party was by no means luxurious. Oatmeal, bacon, potatoes, light bread and dried apples were the staple diet. There were no canned provisions in the commissary.

The maps and profiles of the day's work were made each night by candle light; but the candle on the chief's table burned longer than those anywhere else. Holbrook was a broad-gage, progressive man. A few years later his parties on the Atlantic & Pacific Ry. were supplied with student lamps and a varied bill of fare.

Our transitman was Charles C. Upham, who, three years later, lost five members of his party on Mexican Central Ry. surveys in the sand hills of Chihuahua. These men were intercepted by Victorio's Apaches, and dreading to meet the savages on the advance had left the party to return to the north, when they fell victims in their flight. Upham was later Chief Engineer of the Colorado Ry. Co., a Burlington & Missouri River R.R. enterprise. Many mountain lines were explored under his direction.

He was detached from this work in 1885 to build the Chicago, Burlington & Northern Ry. from St. Paul, Minn., to connections with Chicago and St. Louis. This work, completed in 1887, closed his career as a railway builder, although by no means put an end to his useful activity, for he may be found today as Vice-President and General Manager of the New York Steam Co., at 140 Cedar St., New York City.

To return, after our digression, to the building of the Leadville extension, the writer still retains vivid recollections of how those location surveys under Holbrook were carried up the Arkansas River, sometimes in subzero weather, often in slush and storm, through sunless and almost impassable cañons and over high table-lands covered with piñon forests, to the mouth of California Gulch, and to Leadville, three miles beyond. It was a period when sickness and even death invaded the party.

In the year that followed the completion of this survey I met in the offices at Pueblo, and later became associated with many of those men, who, through heat and cold, in malarial fastnesses, on windswept heights and on trackless deserts, made way for the rails to the South and West, in opposition not only to natural barriers, but to savages, both red and white.

Among them were S. W. Lee, our Office Engineer, and John McGee, both of whom were instrumental in building the Oroya Ry. in Peru. Another was P. F. Barr, Resident Engineer on construction in the Royal Gorge, who was a young giant with a dark beard. Ten years later, as Manager of the St. Paul City Railway Co., Barr installed one of the earliest American cable street railways.

Of the youngsters in the office at Pueblo, Howard V. Hinckley, Charles W. Sanders and myself were from the class of 1876 of the Worcester Polytechnic Institute, and C. F. Allen was of the class of 1872 of the Massachusetts Institute of Technology.

Sanders came to us from Texas, where he had failed in an attempt at sheep raising. He was in Holbrook's party and later served under the latter as Office Engineer on the Atlantic & Pacific Ry. For the greater part of the next 15 years he was in private practice in southern California. Then, driven by asthma to the shore of Lake Superior, he first served as Division Engineer of the Eastern Minnesota Ry., and later as Office Engineer and Chief Engineer of the Copper Range R.R., at Houghton, Mich., where I joined him about three years before his death.

Hinckley was afterward in charge as Office Engineer at Topeka, Kan., for many years. Our paths crossed again in 1902 during the construction of the western extension of the Choctaw, Oklahoma & Gulf R.R. (now a part of the Chicago, Rock Island & Pacific Ry.) He is now a consulting engineer at Oklahoma City.

Allen was afterward Office Engineer of the Santa Fé at Santa Fé and Pueblo, and of the Mexican Central at El Paso del Norte. He also did good work in straightening out the right-of-way matters in the Rio Grande valley. He is now and has been for many years Professor of Railway Engineering at the Massachusetts Institute of Technology.

But to return to those pioneer days; it was during the year 1879 that the D. & R. G. claimed that the terms of the lease to the Santa Fé had not been complied with, and the lease was consequently forfeited. With the aid of the county sheriff they proposed to take charge on a certain day by force of arms. They were well prepared to make a simultaneous move all along the line.

The Santa Fé people decided to hold out at Pueblo. The roundhouse there was garrisoned with "jayhawkers" under the command of Wm. R. Morley. Morley was a fighter. He had contended with Stephen B. Elkins and his gang in New Mexico, and had taken a prominent part in the previously mentioned struggle for the possession of the right-of-way through the Royal Gorge. He made a grand bluff, but the sheriff, well backed by determined deputies, proved too much for him and the roundhouse capitulated, the garrison laid down their arms and went to headquarters for their pay. In the mix-up the telegraph operator was seriously wounded at his post.

Morley left soon afterward and went to Guaymas to build the Sonora Ry., and I joined him there about a year later. He was always alert, and an indefatigable worker. Apparently rollickingly careless, he was actually most systematic. His handwriting was almost illegible, but he did not shirk detail in any sense. He was the idol of a frontier following whose homage was sweet to him, but he could brook no opposition.

Morley was the man who located the Denver & Rio Grande R.R. over the Veta Pass, where a train traverses 14 miles to make a direct advance of 500 ft. He also did some bold work on the Sonora Ry. Although the Mexican climate impaired his health, he stayed with this railway until it was completed, more than three years. With patience he faced unavoidable delays, and with good judgment he met many difficulties. He calmed the fiery land owners who objected to trespass. He satisfied the government inspectors while at the same time insisting on fair play, and accomplished great things in spite of the handicap of official interference.

Late in 1882, Morley took charge of the Northern division of the Mexican Central Ry., 700 miles in all with 500 miles of track yet to be laid. I followed him to Chihuahua shortly afterward, but I never saw him again alive. On his return from a reconnaissance to the south he was shot and almost instantly killed by the accidental discharge of a rifle.

John E. Earley, Morley's principal assistant, was appointed acting Chief Engineer. Earley had spent several years on railway location in New Mexico, Arizona and Mexico, and much of the time had worked in close proximity to Victorio's terrible Apaches. Earley was a rotund little Yankee, tenacious and conservative, but of mild and agreeable demeanor. Quietly determined but not aggressive, his 40 years sat well upon him. The cut of his nether apparel, that of a generation or two past, was typical of his conservatism. After about three months' service he was superseded by Lewis Kingman as Chief Engineer. The remainder of his life was spent in Southern Mexico, mostly on railway location and construction.

Kingman had already made his mark on the Santa Fé. It was he who located the railway up the Pecos Valley, 27 miles on a supported grade to Glorieta summit. Later he located the Atlantic & Pacific Ry. across the Arizona tablelands, a masterpiece of railway location. He succeeded Holbrook as Chief Engineer of the Atlantic & Pacific in January, 1882. As a man he was introspective, dark and melancholy to the casual observer, shy in manner, but nevertheless very aggressive; a tireless worker and a master of detail. He would even step into the drafting room and dictate the width of a margin. He strove to cultivate an affable bearing, but was handicapped by his temperament. He remained a railway builder and engineer to the last, with one slight interruption: He died recently in Mexico.*

In order to follow the career of Morley and his successors, I have been obliged again to wander from the early days of the Santa Fé. About the first of January, 1880, it became necessary to rush the building of the pile bridges on the branch from Lamy to Santa Fé. The track was due in Santa Fé on Mar. 1, under a stiff penalty, and there were 68 bridges in 18 miles. Track work was being rushed on the main line toward the Rio Grande at the same time. The big cut at Glorieta was not completed, but construction trains were going over the summit on a temporary grade of 6%. E. A. Handy was staking out pile bridges on the main line while I was doing like work on the branch. Handy was a sturdy fellow, somewhat impressed with the importance of his work. He ended his career as Chief Engineer of the Lake Shore & Michigan Southern Ry.

The engineer in charge of grading was R. L. Engle, with headquarters in Santa Fé. "By that means I save the company the price of a postage stamp" were the first words I heard him say. But Engle was not of the picayune order. He was a man of heavy mold but average height, and extremely neat in dress, a man of natural dignity, straight-forward and averse to red tape. He did not believe in applying the prismoidal correction to end area quantities. His manner of speech was hardly up to his otherwise impressive personality, but he held the respect and affection of his subordinates generally.

Engle's reputation as a locating engineer had already been well established. He had begun his railway career soon after the Civil War and his experience in railway location and construction before he died in 1909 covered a wide territory.

These few recollections of some of the Santa Fé pioneers, hastily penned from memory only, may have been slightly warped by personal bias, or may be otherwise faulty. However, they will serve to place on record some of the achievements and characteristic qualities, as personally observed by a subordinate, of representative men of our profession, who had to cope with difficulties and dangers in some respects greater than those of the present day.

*Eng. News, Feb. 8, 1912.

The Cement Industry in 1911*

The statistics of cement production in 1911, prepared by Ernest F. Burchard, of the U. S. Geological Survey, show an increase over 1910 of only about a million and a half barrels. The increase in quantity is the smallest recorded within the last 13 years, and the fact that the total value showed an actual decrease indicates that trade conditions were not as satisfactory in 1911 as in 1910.

PRODUCTION—The total quantity of portland, natural, and puzzolan cements produced in the United States during 1911 was 79,547,958 bbl., valued at $66,705,136. Compared with 1910, when the production was 77,785,141 bbl., valued at $68,752,092, the year 1911 showed an increase of 1,762,817 bbl., or 2.27% in quantity, but a decrease of $2,046,956, or 1.48% in value.

The total production of portland cement in the United States in 1911 was 78,528,637 bbl., valued at $66,248,817. This quantity reduced to tons is equivalent to 13,321,822 long tons, valued at $4.97 per ton. As compared with the production of portland cement for 1910, which was 76,549,951 bbl., valued at $68,205,800, the output for 1911 represents an increase in quantity of 2.58%, and a decrease in value of 2.87%. The average price per barrel in 1911 was a trifle less than 84.4c., as compared with 89.1c. in 1910. In the average price for the country is included the value of 135,775 bbl. of white portland cement which sold at an average price of about $2.50 per bbl.

COMMERCIAL DISTRICTS — The United States has been divided into 11 subdivisions based on the grouping of plants in direct relation to the trade territory covered by each group. This grouping is also logical when the raw materials are considered. For instance the plants in northeastern Indiana and northern Kentucky, all of which are near the Ohio River and all of which use hard limestone, are grouped together. Plants near Chicago, whether in Illinois or Indiana, are grouped together because of their nearly equal freight rates. The Southeastern States, in which plants use mostly Appalachian limestone, are grouped together, and central Texas is included in the group of Great Plains States. Plants between Missouri River and Mississippi River in Missouri and Iowa are grouped together and the plants in the Rocky Mountain States and western Texas are considered in a group intermediate between the Great Plains and the Pacific Coast. The following table summarizes the statistics for 1911 for each district with regard to the number of active plants, the total production, the percentage of gain and loss in 1911, and the average price per barrel.

*Advance proof of the annual report of the U. S. Geological Survey.

PRODUCTION OF PORTLAND CEMENT IN 1911 BY COMMERCIAL DISTRICTS

District	Active plants	Production, 1911, barrels	Change, 1911 Per Ct.	Average factory price per bbl.
New Jersey and eastern Pennsylvania (Lehigh district)	24	25,972,108	—1.30	$0.715
New York	7	3,314,217	+1.54	0.805
Ohio and western Pennsylvania	9	6,756,313	+11.25	0.766
Michigan and northeastern Indiana	13	4,519,726	—0.11	0.827
Kentucky and southern Indiana	3	2,818,820	—0.21	0.793
Illinois and northwestern Indiana	6	8,617,341	+2.88	0.791
Southeastern States (Maryland, Virginia, West Virginia, Georgia and Alabama)	11	4,049,063	+31.85	0.793
Iowa and Missouri	7	6,067,449	+6.02	0.862
Great Plains States (Kansas, Oklahoma and central Texas)	17	7,010,396	—9.23	0.834
Rocky Mountain States (Colorado, Utah, Montana, Arizona and western Texas)	7	2,124,930	—4.99	1.186
Pacific Coast States (California and Washington)	11	7,278,274	+13.98	1.406
Total	115	78,528,637	+2.58	0.844

PRICES OF CEMENT—According to reports made to the United States Geological Survey by the manufacturers the average price of portland cement per barrel by districts in 1911 in bulk at the mills ranged between 71.5c. in the Lehigh district, and $1.406 on the Pacific coast, as compared with 72.9c. and $1.385 for the same districts in 1910. The average price for the whole country was 84.4c. per barrel. The lowest individual average price reported to the Survey was 60c. per barrel, and many mills sold cement as low as 65 to 67c., not only in the East but in the Middle West. The highest figure reported was $1.70 per barrel from a plant in the Rocky Mountain district.

The year opened with the prices on the downward grade, and there were only temporary revivals.

NEW PLANTS—In 1911, 115 plants reported a production of portland cement as compared with 111 plants in 1910. The total number of rotary kilns in the producing plants was 916 as compared with 902 in 1910. These kilns ranged in length from 40 to 240 ft. The kiln lengths were as follows: 40 to 60 ft., 208 kilns; 60 to 90 ft., 149 kilns; 100 ft., 84 kilns; 110 ft., 140 kilns; 120 ft., 86 kilns; 125 ft., 163 kilns; 125 to 140 ft., 60 kilns; 150 ft. or more, 26 kilns.

The Condition of the "Maine" After 13 Years' Submersion

By Maximilian Toch*

In November, 1909, I made an examination of the mast and the superstructure then above the water of the battleship "Maine," which had been sunk on Feb. 15, 1898, in Havana Harbor, and found that the paint on the mast was still in fair condition considering that it had been

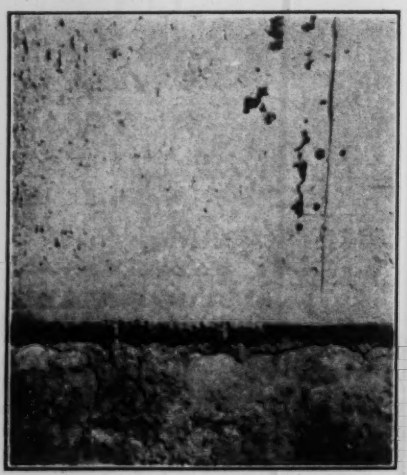


Fig. 1. Corroded Plates in the Deck-House of the Battleship "Maine"

exposed to the elements over 10 years. It occurred to me, in view of the fact that the Eighth International Congress of Applied Chemistry was to convene here in September, 1912, that I might make some investigation as president of the section

Fig. 2. An Old Pump from the "Maine" Refitted and in Service

on paints, to see whether any paint was left on the battleship when the hulk was exposed, and what was the condition of the metal.

I went to Havana in February, 1912, and in order that my investigations might be carried out to the fullest extent, the State, War and Navy Departments furnished me with the necessary credentials, and gave every possible opportunity of making the examination desired.

Furthermore, Major Ferguson and Capt. Watt, in charge of the raising of the hulk, showed me every possible courtesy and assistance, and I am glad to take this opportunity to acknowledge it. The results are published with the consent of Col. Black, chief in command of the engineering forces at the work.

I requested that the plates examined, both in the interior and exterior of the "Maine," should be cut out and sent to the museum of the College of the City of New York, and these relics are now on exhibition in the museum there.

A number of people, who evidently had not been well informed, stated to me that the old "Maine" was largely composed of wrought and cast iron. Upon investigation I found that the battleship was made

Fig. 3. Steel Ventilator and Bronze Compass Boxes

of modern steel (being commissioned at the New York Navy Yard on Sept. 17, 1895), and those parts of it that were of wrought and cast iron were the pumps and anchor chains.

The vessel had settled down in mud up to within a few feet of the top deck. A careful examination of the interior and exterior of the ship showed absolutely no trace of any protective material in the way of paint. The wooden floors which were below the mud line and which were likewise the same floors which formed the ceilings of the deck below, were in as perfect a condition as perhaps the day that the ship was sunk, but no trace of paint was visible anywhere; a section of the pine timbers forming these floors is on exhibition at the museum in the College of the City of New York.

Directly above the mud line the teredo had bored the wood until nothing but the thinnest shells were left. It is well known that the teredo will never cross its own track or that of another, so that all these borings run longitudinally until at last a honey-combed action is the result. The walls between the borings are at times microscopic in their thinness. Most astonishing in all of this, the popular impression. that the teredo is active only between high and low water, was not borne out by the condition of the wood on the "Maine," for there was not a vestige of pine left in good condition above the mud line, but wherever there was any mahogany it had been left practically untouched.

The condition of the steel and metal in the battleship "Maine" is best shown in connection with the accompanying illustrations.

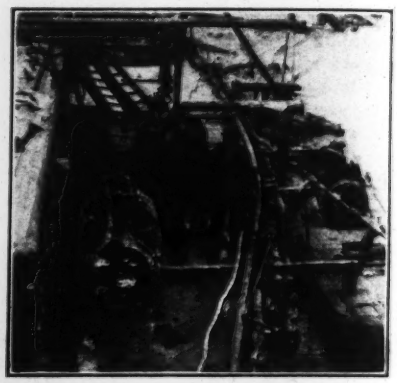


Fig. 4. Copper-Bronze Hose Reel

Fig. 1 shows the outside of the battleship after the mollusks had been removed. On the lower section of the plate (which was in the deck house alongside and at the right of the pump in Fig. 2) there were a few places where holes had been eaten into the plate, and that was practically the only part of the entire outside of the ship that had been corroded all the way through. The rust had

Fig. 5. Boiler-Room Air Shaft Wall

formed in scales to a thickness of fully an inch in some places, but the mollusks, which looked to me more like oysters and clams than barnacles, had become so thick in other places that evidently corrosion could not continue.

Fig. 2 shows a very interesting condition. Here is one of the pumps which

*Toch Bros., 320 Fifth Ave., New York City.

was taken out of the interior of the "Maine," cleaned up and refitted with new connecting rods. The very pumps which had lain dormant in the interior of the "Maine" were used in pumping the mud out of the vessel. The pumps were a Blake type and made of materials as follows:

FIG. 6. RAPID-FIRE-GUN MOUNTS AND HATCH FITTINGS

Steam cylinders	cast iron
Water cylinders	bronze
Steam pistons	cast iron
Water plungers	bronze
Piston rods	forged steel
Plunger rods	bronze
Valves, guards and springs	bronze
Piston rings (steam)	cast iron
Framing	cast iron, with wrought-iron columns

The piston rods were corroded, but the balance of the pumps were in very good condition.

These pumps were principally composed of cast iron, and it is well known that cast iron does not easily corrode. In the ordinary sense, this has always been accepted, but I doubt very much whether any one would have believed that cast iron, after lying imbedded in mud and salt water for 13 years, would be in practically perfect condition at the end of that time.

Fig. 3 shows a very interesting illustration of electrolytic corrosion. The figure on the right-hand side is all that remained of what was once an 8-ft. ventilator made from ¼-in. steel. The lighter figures in the left center were bronze compass boxes. The bronze of the boxes and the steel ventilators had formed an electric couple, the steel naturally becoming the anode, and having been wasted away. The compass boxes, except for the incrustation of a few mollusks, were in perfect condition.

In Fig. 4 is another example of this. The hose reel on the lower left-hand side was also of copper bronze and in a perfect state of preservation; the photograph, Fig. 1, was taken in close proximity to this copper reel, which accounts for the severe corrosion at that place.

The most serious corrosion is shown in Fig. 5; here the plate was originally 1 in. thick and was the wall of the air shaft leading down to the boiler room on the second deck. The corrosion had been practically complete in many places and the plates had been eaten through. The plate photographed is now in the City College museum. Rust on the bow plates was not over 1 in. deep, and the anchor chains were in a most excellent condition. The conning tower, which had been blown about 80 ft. back from its original position, was in a dilapidated state and very poorly preserved. As near as I could judge the conning tower was entirely submerged in salt water and was not near the mud line.

Fig. 6 shows various fittings such as rapid-fire-gun mounts, hatches, etc., all in a most excellent condition. Fig. 7 shows one of the 10-in. guns taken out of the forward turret; the corrosion around the breech was practically complete. I have been reliably informed that a number of the fittings of the breach were of brass which would account for the excessive corosion. Any steel near the brass would be an anode which would necessarily be dissolved away.

Fig. 8 is the original mast of the "Maine" which, when I had examined it in 1908, showed but a few rust spots and the major portion of the paint in excellent state. Below the water there was no sign of any pigment whatever.

The ammunition cases, such as the Krag-Jorgensen 30-caliber cartridge for the rifles, were very largely in good condition, for the obvious reason that the shells were composed of copper. The brass cases for the larger guns were also in excellent condition. Quite a number of the smaller rifle shells still could be exploded on handling, and although they went off with a very weak report, there was sufficient force left to show that the smokeless powder had not been entirely decomposed in 13 years.

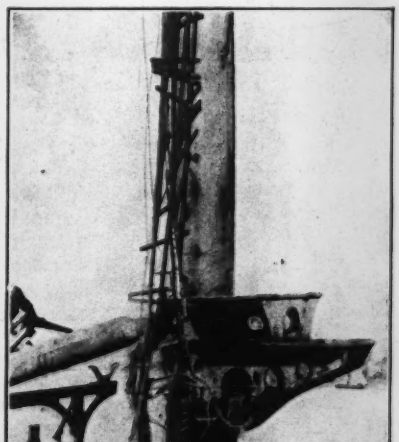


FIG. 8. MAST OF BATTLESHIP "MAINE" BEFORE REMOVAL

Both hard and flexible rubber packings were as perfectly preserved as the day on which they were submerged. There is no doubt that the salt water and the exclusion of the air prevented any decomposition. Samples of this packing are on exhibition at the museum of the College of the City of New York.

The skeletons of all the bodies found were entirely disarticulated. No vestige of clothing, with the exception of such metallic objects as were in or on them, remained, but it is worthy of note that in

FIG. 7. CORRODED BREECH OF 10-IN GUN

13 years the bones had suffered no decomposition whatever.

The conclusions that must be drawn from this investigation show that the incrustation of steel by submarine animal growths is, in a measure, a protection of that steel, for it was to be presumed that in 13 years much more corrosion would have taken place on the battleship than was apparent.

The belief that the teredo works only between high and low water is evidently not well established, for there was no mean tide in this instance, and yet all the wood above the mud line had disappeared with the exception of the hardwoods.

The materials of different electrolytic potentials placed in salt water re-act upon each other and, even under conditions such as would be produced by the mud, water, and incrustations, steel in the proximity of copper and bronze is likely ta be electrolytically eroded.

A Mallet Articulated Locomotive of 115,000 lb. tractive power has been built for pusher service on the Deepwater Division of the Virginian Ry., and will enable a train load of 4230 tons to be operated over a grade of 2.07%, 14 miles long. The present load here, with one road engine and two pushers (all of the Mallet type), is 3340 tons, while for the rest of the division the road engine alone can handle 4230 tons. The engine is of the 2:8:8:2 class, with a total weight of 270 tons, and the weight on the drivers averages less than 25 tons per axle. The cylinders are 28x32 and 44x32 in., and the drivng wheels 56 in. diameter. The boiler is 8 ft. 4 in. diameter, with a firebox 7x10 sq.ft.; it has 6760 sq.ft. of heating surface and 1310 sq.ft. of superheating surface. Four of these immense engines are being built by the American Locomotive Co.

City Refuse Disposal at Seattle

By Geo. Holmes Moore*

Seattle was one of the earliest American cities to make an engineering study of refuse collection and disposal and to build a refuse destructor of an improved British type. It now has two such destructors in use and a third under construction. The history of this municipal enterprise is here sketched. One of the later destructors is described and two years' operating results of the first destructor are given. Finally the author makes some comments on the utilization of heat from refuse destructors for generating electricity.

Prior to the inauguration of destructors, the refuse of Seattle was dumped at sea. This was highly unsatisfactory, for Seattle, while possessing an unsurpassed harbor, is many miles from the main sweep of the great ocean currents. Furthermore, garbage dumping in the main harbor of Elliott Bay was prohibited some years ago by the United States government. The city had something like 300 tons of refuse to dispose of daily, and as the amount was rising steadily with the remarkably rapid increase of population it was urgently necessary that some solution should be attained. It was under these circumstances that R. H. Thomson, then city engineer of Seattle, made an exhaustive investigation of the methods of refuse disposal then in operation in a great number of large cities both in the United States and Europe.

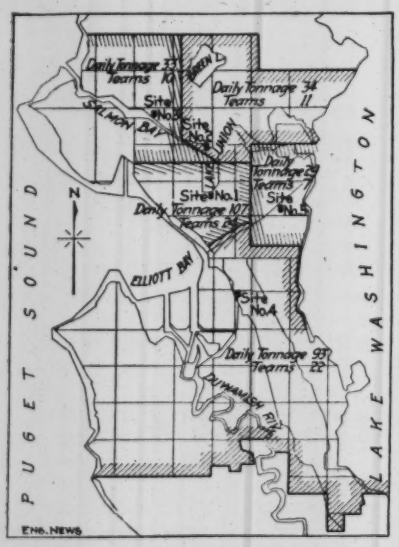


FIG. 1. LOCATION OF REFUSE DESTRUCTORS AT SEATTLE, WASH., AS PLANNED FOR POPULATION OF 240,000

The direct result of this investigation was the inauguration of the system of disposal by incineration in refuse destructors, a system which has now been in operation for about four years.

THE GENERAL PLAN OF COLLECTION AND DISPOSAL

In order that the destructors might be so located as not only to serve the present population, but also to be in accord with the future development of the city, a complete study of the situation was made to meet (1) the present conditions with a population of 240,000, and (2) the future conditions for serving a population of 1,000,000.

The installation, as designed to handle the refuse under the present conditions, contemplates the construction of five 60-ton destructor plants, located (see Fig. 1) as follows: (1) Boren Ave. N. and Valley St.; (2) Wallingford and Northlake Aves.; (3) 9th Ave. N. W. and West 42d St.; (4) 9th Ave. S. and Massachusetts St.; (5) 30th Ave. N. and Mercer St.

*Formerly secretary of the Seattle Section of the American Institute of Electrical Engineers; now in the office of the city engineer of Seattle, Wash.

The amount of refuse to be handled at each plant, the capacity of the plant, the number of teams required for collection, and similar items were computed from the data at hand, the results being as shown in Table I.

AMOUNT OF REFUSE—The estimated amount of refuse was based on population. In order to distribute the population into districts over the city the number of people registered Nov. 1, 1910, for the different precincts was multiplied by five in each case, to arrive at the assumed population for the precinct, the total amounting to 240,000. The amount of refuse per capita is estimated to vary from 3½ lb. per day in the business and heavy apartments districts to 2 lb. per day in the residential districts. Using these rates, with the population figures as allotted to the various plant districts, gave the total daily tonnage and the plant capacity.

NUMBER OF COLLECTION TEAMS—The next step was to estimate the number of teams required to haul the refuse to the various plants. A variety of different elements had to be considered under this head. The average load being estimated as 1.6 tons, the total tonnage per week was divided by this figure to give the number of loads per precinct per week. Each precinct or part of precinct was considered as a unit and the distance from its average central location was scaled as the distance to the plant for all loads from that precinct.

TIME FOR LOADING—The time to load each wagon is variable, dependent upon the density of population and upon the per capita amount of refuse. It was arrived at by dividing the number of tons per precinct by the acreage of the precinct, thus obtaining a figure known as the density rate in tons per acre. The maximum assumed time of loading was 2.7 hours and the minimum 0.5 hour, the time for any given precinct varying with its density rate.

The average traveling rate of the wagons, going and coming, was taken as 2.75 miles per hour and the number of hours to haul to plant was then obtained by dividing double the plant-to-precinct distance by the constant of 14,500 ft. The time to unload was estimated as being approximately 0.25 hour per load.

The total number of hours required to haul the week's accumulation of refuse in each precinct was divided by six and again by eight in order to reduce it to the six-day a week, eight-hour per day basis.

STREET SWEEPINGS—Street sweepings were not included in the estimate, but will have to be taken care of later. They are estimated to amount to about 1 lb. per person per day in the business and close-in district. It may be noted in passing that the streets in the business districts of Seattle are washed nightly with a special wheeled arrangement which permits the convenient use of fire

TABLE I. REFUSE COLLECTION AND INCINERATION ESTIMATES, SEATTLE, WASH.
(240,000 population)

Plant No.	Daily tonnage	Number of: Cells	Teams	Men at plant	Men for collection	Men at barns
1	107	6	24	25	40	4
2	35	3	11	7	20	[illegible]
3	33	2	10	7	17	[illegible]
4	93	5	22	16	36	[illegible]
5	29	2	7	6	12	[illegible]
Totals	296	18	74	61	125	12

COST OF COLLECTION PER TON

Plant No.	Teams	Men for collection	Men at barns	Total	Cost of incineration at plant	Grand total cost per ton
1	$0.79	$1.03	$0.12	$1.94	$0.70	$2.64
2	1.10	1.57	1.17	2.84	0.60	3.44
3	1.06	1.42	0.18	2.66	0.63	3.29
4	0.83	1.06	0.09	1.98	0.52	2.50
5	0.84	1.14	0.12	2.10	0.62	2.72
Total						$14.59
Average per ton						$2.92
Superintendence						0.15
Total						$3.07

those for this purpose, the steep slopes of the streets and storm sewers making this method very effective.

UNIMPROVED TERRITORY—In making up the estimate, no allowance was made for collection of refuse in ungraded territory or in territory without reasonably accessible roads. For precincts where the streets are permanently improved, the installation of auto trucks was considered, it being estimated that the number of teams could be thus reduced one-sixth and the number of men one-fifth in such districts.

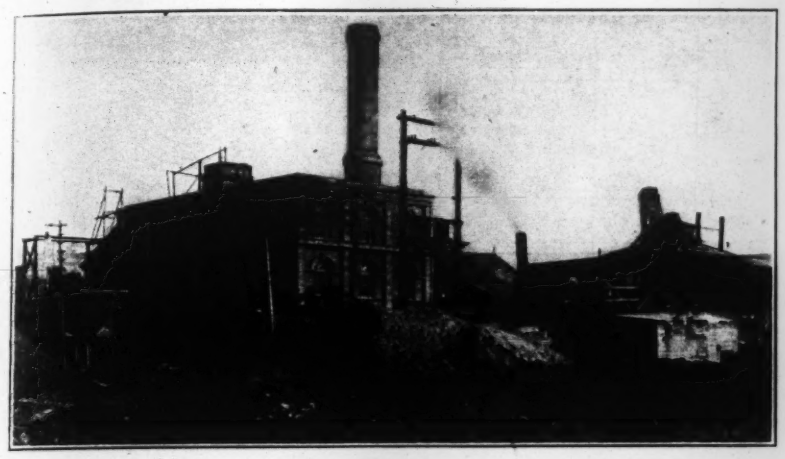


FIG. 2. VIEW OF REFUSE DESTRUCTOR BUILDING NO. 1, SEATTLE, WASH.

(The clinker sifter, for use in preparing cinders for concrete, shows at the left. On the right is the municipal asphalt plant).

BASIS FOR FUTURE ESTIMATES—In making studies for the purpose of estimating the requirements for the disposal of refuse when Seattle has a population of 1,000,000, the city was laid off into districts such as business, apartment, residential and similar. The population density of these districts was taken at the following figures:

	Population per acre
Business district	200
Semi-business and apartment	75
Manufacturing	5
Railroad terminals and manufacturing No. 2	2½
Residential No. 1	30
Residential No. 2	15
Residential No. 3	3.33

PROGRESS OF PLANT INSTALLATION—The first plant to be installed (Fig. 2) was located on the south shore of Lake Union, the latter being a body of water located approximately in the area center of the city, and being about a mile northerly from the main business section. This gave the initial plant a situation approximately central as to area and sufficiently close to the business districts to allow a test of widely varying characters of refuse supply.

This installation comprised a complete incinerator plant, based on the Meldrum patents, and designed to dispose of 60 tons of refuse per 24-hour day.

Destructor No. 1 has been in continuous successful operation for over four years, having been started in February, 1908, and the results obtained by it have amply justified the installation of similar plants elsewhere in the city.

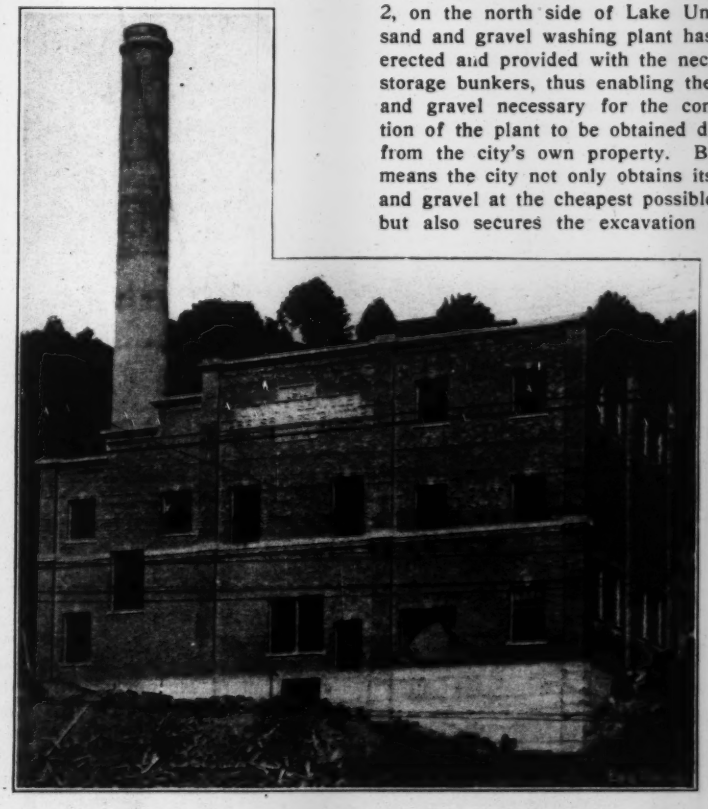


FIG. 3. VIEW OF REFUSE DESTRUCTOR BUILDING NO. 4, SEATTLE, WASH., LOOKING UP SIDEHILL

One of these, No. 4, is already completed and at work, having been placed in operation during August, 1911. This is located, as previously noted, at 9th Ave. S. and Massachusetts St., a mile or so southward from the denser business section, and and is designed to serve the southerly portion of the city.

Still a third plant, Destructor No. 2, has been authorized and is now under construction. It is located on the north shore of Lake Union and is designed to serve the district lying northerly of the Lake Washington Ship Canal.

All three of these destructors are of the same general type, being based on the Meldrum patent, the right to which was secured by the city at the time Destructor No. 1 was erected. The only essential departure from the design of No. 1 was in the adoption, in Nos. 2 and 4, of a system of top-feeding to take the place of the original hand feed. This change was expected to reduce the labor cost, and also to aid in maintaining a higher temperature in the furnace by avoiding the frequent openings of the large front doors. The results obtained in the operation of Destructor No. 4 prove that both these points have been attained and no trouble has been experienced in maintaining the rated capacity of 60 tons of refuse per 24 hours.

In the construction of Destructor No. 2, on the north side of Lake Union, a sand and gravel washing plant has been erected and provided with the necessary storage bunkers, thus enabling the sand and gravel necessary for the construction of the plant to be obtained directly from the city's own property. By this means the city not only obtains its sand and gravel at the cheapest possible rate, but also secures the excavation of its property to street grade without additional expense.

REFUSE COLLECTION—The first step in refuse destruction is the collection of the refuse. But as this branch of the work

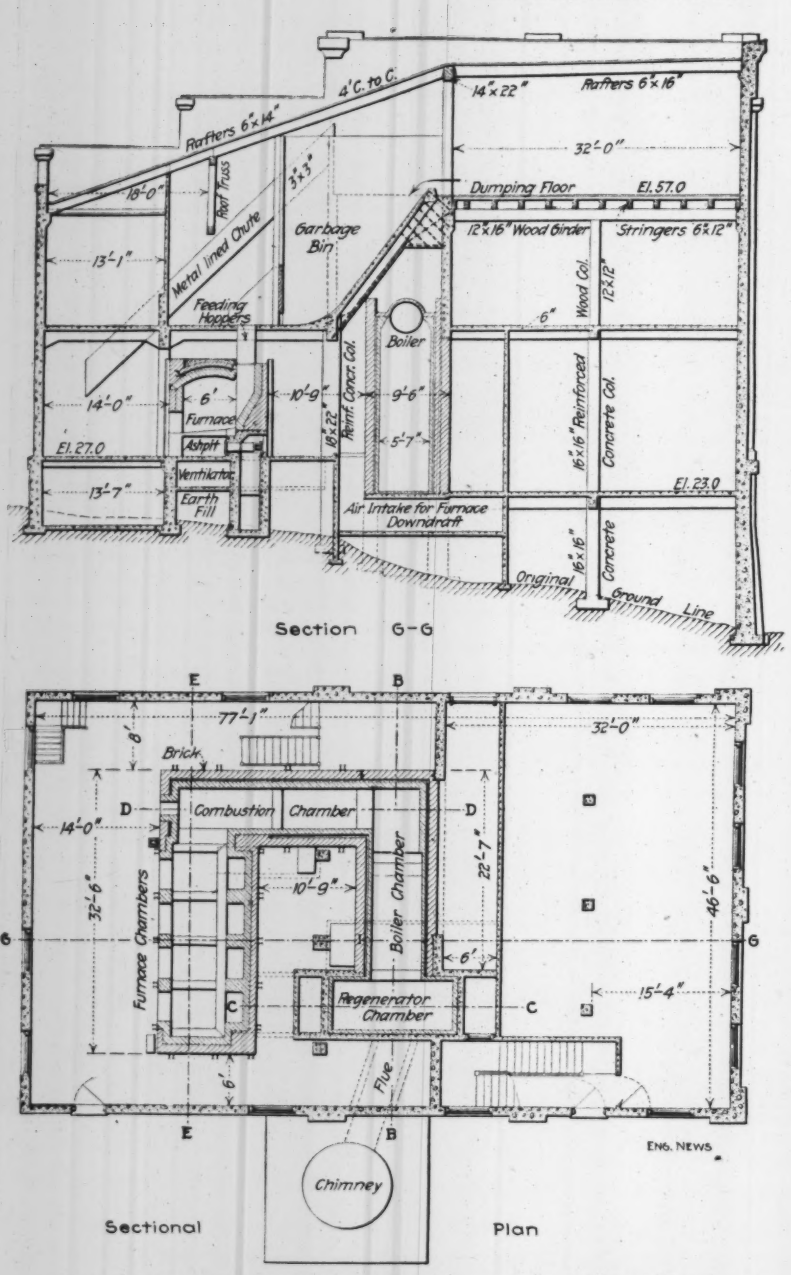


FIG. 4. PLAN AND SECTION OF REFUSE DESTRUCTOR, SEATTLE, WASH.

presents no new problems or methods, with the possible exception of the gradual substitution of five-ton motor trucks to take the place of one-horse and two-horse dump-carts formerly in use, it will not be dwelt upon here. It may be noted in passing that the hauling expense is not infrequently as high as 75% of the complete disposal cost. Or, if differently stated, we may say that, with modern methods of incineration, it costs only a third as much for the destruction of the refuse as is required for its collection.

DETAILED DESCRIPTION OF TYPICAL PLANT

Perhaps the best idea of the most modern of these plants can be obtained from the following description of Destructor No. 2. This is to be contained in a three-story concrete building, measuring roughly 50x80 ft. in plan. Fig. 3 is a view and Fig. 4 gives a plan and a section of this structure, while Fig. 5 shows a number of details of the destructor. The section shown by Fig. 4 will be of assistance in following the description given below, the process being outlined from experience with Destructor No. 4.

REFUSE INCINERATION — In order to facilitate the handling of the refuse, it is delivered by wagons or motor trucks to the third floor of the building, by means of a long trestle incline of flat gradient.

TABLE II. OPERATING RESULTS SEATTLE DESTRUCTOR No. 1, JULY 31, 1908, TO AUG. 1, 1910.*

Refuse consumed by furnace	42,580.5 tons
Estimated tins, scrap and glass going to dump	502.5 tons
Estimated rubbish burned on dump	2,068.6 tons
Total refuse handled	45,151.6 tons
Ash and clinker drawn from furnace	18,391.0 tons
Ash and dust from combustion chamber and flues	931.0 tons
Evaporated or consumed by the furnace (51.5%)	23,258.6 tons
Average daily consumption —furnace and dump	74.3 tons
Average daily consumption by furnace	70.0 tons
Total number of loads of refuse disposed of	27,399
Average number of loads of refuse disposed of per day	45.0
Average weight of the loads of refuse delivered	3,296 lb.
Total time expended for clinkering fires	3,055 hr.
Total number of fires clinkered	14,426
Average time required to clinker each fire	12 min. 42 sec.
Average time each fire was burning	3 hr. 12 min.
Average weight of clinker drawn from each fire	2,550 lb.
Daily evaporation by boiler (average for 608 days)	140,068 lb.
Average hourly evaporation —from and at 212 deg. F.	204 hp.
Water evaporated per lb. of refuse	About 1 lb.
Expense and revenue:	
Wages as per payroll total for burning refuse and handling byproducts	$33,256.19
Received from sale of clinker and clinker sand	2,466.00
Received from sale of power	719.42
Compensation per ton of refuse handled:	
Cash from sale of clinker	0.0546
Cash from sale of power	0.0159
Total cash per ton of refuse handled	0.0705
Property improved by fill —arbitrary credit	0.200
Total cash and credit per ton of refuse handled	0.2705
Total cost (per ton of refuse burned) of burning and handling byproducts	0.7365
Net cost, per ton, of handling the refuse at the destructor	0.466

The average percentage composition of the refuse burned has been as follows: Ash, 43.5; manure, 4; garbage, 32.1; rubbish, 20.4.

The average temperatures from daily readings in degrees Fahrenheit have been: In the combustion chamber, 2376; at the base of the stack, 547; at the inlet to the regenerator, 74; at the ashpit, 368. The gain in the regenerator has averaged 194°.

The gas analysis at the stack base has shown a percentage of CO_2 to be 10.2, of O, 4.7, and of CO, 0.6. Results of weather observations indicate that during the period covered by the accompanying data 325 days were clear, 198 cloudy, and 85 rainy. The average water-gage readings show ½ in. at the base of the stack, without forced draft, and 1⅜ in. back pressure, at the ashpit door of grate.

*In 1910 the operation of the destructor was transferred from the city engineer to the department of health and sanitation. Since this transfer, no additional records have been kept, the tests previously made being considered conclusive and sufficient.

Just before passing to the dumping floor, the wagon goes onto a platform scale where the weight of its contents is noted and recorded. From the dumping floor, the refuse slides down the inclined side of the concrete "Garbage Bin" to the "Feed Hoppers" on the second floor. Here the material is fed by attendants, armed with heavy three-pronged, steel rakes, to the furnaces located on the first floor.

This is the initial point of the incineration process proper, and a glance through

the stoke hole at the mass of what seems to be mostly ashes and dirt is sufficient to inspire in the beholder a very real respect for the plant which effectively disposes of it. The actual composition of the refuse will be evident from Table II.

At the furnace, the mass is manipulated through a small stoke-hole by means of ordinary stoking irons, the process being very similar to the familiar one of firing an ordinary boiler furnace when burning dirty coal or slack. Steam jets are provided to produce a strong draft, and precautions are taken to exclude air from the furnace chamber above the refuse mass.

Leaving the furnace proper, the hot or incandescent gases are drawn into that interesting part of the plant called the combustion chamber. This is a large chamber lined with firebrick and provided with baffles and deflectors which, by giving a whirling motion to the gases, insure an intimate mixture of those gases and tend to produce perfect combustion.

Leaving the combustion chamber, the gases pass to the boiler chamber, a passage at right angles to the combustion chamber. Here they pass upward, through the boiler tubes at the front of the boiler, over the baffle wall and down through the tubes at the rear. From here they pass upward into the regenerator, down through the interior of its tubes and thence through the flue into the chimney.

The regenerator serves the purpose of heating the incoming air for the furnaces, and is similar to the tube nest of a fire-tube boiler, except that the tube exteriors are surrounded by air instead of water. It may be noted here that this incoming air supply travels a considerable distance over many warm or hot surfaces before reaching the furnace, a feature that will be dwelt upon at greater length elsewhere in this description.

The chimney (of No. 4) is of reinforced concrete, 8 ft. in inside diameter at the base, 6 ft. at the top, and 125 ft. high.

No fans or other draft systems are required beyond the furnace, an entirely adequate draft being obtained by the high chimney, aided, when necessary, by the live steam jets in the ash pits.

RESIDUE FROM PLANT—It will be noted that no attempt is made at segregating the different components of the refuse supply, the only possible exception being that some of the heavier iron or porcelain articles which produce a troublesome slag are sometimes removed before the mass passes to the feeding hoppers.

The only residue from the plant, unless we so regard the unobjectionable gases which leave the chimney top, is the ash and slag which forms in the furnace chamber. This is removed from the furnace grates with stoking tools and dropped — often incandescent — through holes in the floor of the furnace room, into a steel ash truck waiting on the rails of an industrial railway laid on the basement floor. From here it is wheeled to the dump and there discharged.

SIMPLICITY OF OPERATION — From an inspection of the preceding, it becomes evident that the labor involved in the handling of the refuse is a minimum, since the refuse flows through the plant, from dumping floor to ash pit, literally by the force of gravity, and along the shortest possible path.

The hot gases, on the other hand, follow a path of considerable length in order, by obtaining the most intimate possible mixture, to promote perfect combustion and so to completely remove from them all those ill-smelling vapors upon whose complete elimination the whole success of the plant depends.

One of the important points in the operating process, previously referred to here, is the path taken by the incoming air prior to its arrival beneath the furnace grates. The supply is taken from the furnace room above the fire-doors, thus serving the double purpose of lowering the temperature of, and removing dust and noxious gases from, the latter. Entering through a passage above the furnace roof, it passes around the feeding hoppers, down and under the boiler setting, across over the heated tube exteriors of the regenerator, and thence along a passage back to the steam-jet cylinder. Here it is forced by the jets up into the refuse bed on the furnace grates. Passing through this, it enters the combustion chamber as hot or incandescent gases, the path of which has already been described.

POSSIBILITIES OF STEAM PRODUCTION— One of the most alluring theories concerning the operation of refuse destructors is that which proposes to generate steam for the operation of turbines driving electric generators. This, as a matter of fact, is, under certain circumstances, entirely feasible. That is, if all ashes and incombustible refuse were separated from the mass fed to the destructor, a very considerable amount of steam could be generated in the plant boilers. Moreover, since the proportion of ash and incombustible varies from 50% to 75% of the total delivered to the plant, the amount of garbage and combustible refuse which the plant could handle would be greatly increased.

But, as weighed against the above, the following facts are to be considered:

(1) The cost of plant operation is subordinate to the cost of collection, as previously stated, often only one-fourth of the total when the plant uses its steam solely to aid in the incineration, and when handling all classes of refuse.

(2) The cost of haulage for the ash and incombustibles would probably be increased, since the probable points of their disposal would be at greater distance from the centers of collection than the incinerators are.

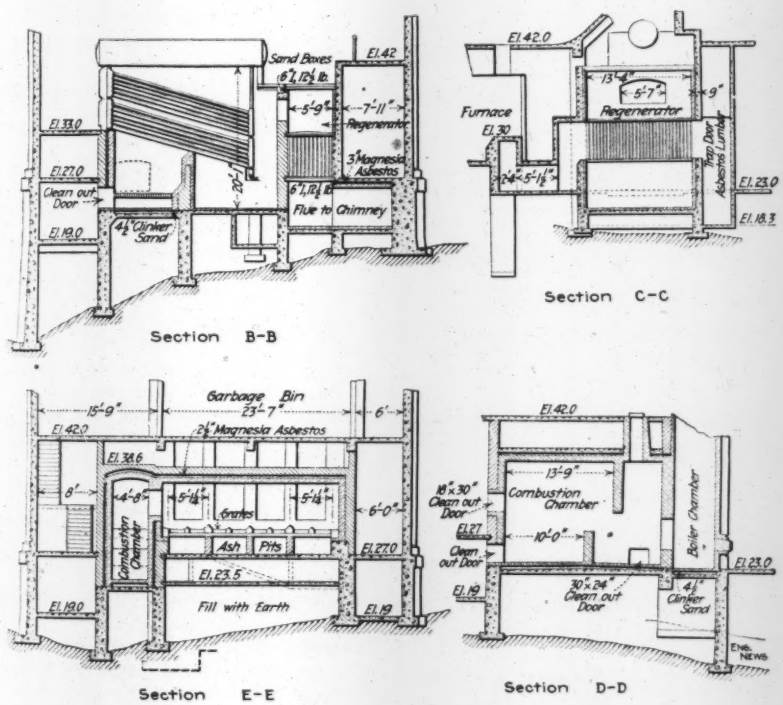


FIG. 5. DETAILS OF REFUSE DESTRUCTOR, SEATTLE, WASH.

(The section letters "C-C," "D-D," etc., refer to the plan, Fig. 4).

(3) The unconsumed coal and combustible rubbish found among the ashes would be wasted.

(4) Each householder would be required to maintain separate cans for ashes and for garbage and two separate collection systems would have to be maintained.

However, this is by no means a settled question and it is not impossible that future plants may have a very considerable installation of electrical generators. But the present attitude of those in charge of the refuse destruction system of Seattle seems to indicate that up to the present time the weight of experience and operating economy is against the proposition of refuse segregation.

CONCLUSION—All in all, the operation of refuse destructors at Seattle may be listed as a gratifying success—a pleasant answer to a puzzling and by no means pleasant problem. While in its infancy, the system had to struggle against the attacks of the yellow press and against the mental inertia of the hostile and uninformed, yet the successful operation of the pioneer plant has disarmed almost completely any adverse criticisms and won a place in the confidence of the people.

No opposition now seems likely to be brought against the installation of future plants or against the harmonious development of the entire system along the lines previously outlined herein.

The roll of those to whose loyal and efficient service the Seattle system of refuse disposal owes its present success is too long to be here enumerated. Acknowledgment for much of the information used in this article is made to District Engineer I. W. Embury, under whose supervision Destructor No. 4 was installed and placed in operation, and to City Engineer A. H. Dimock, by whose permission this description is given.

A Joint Trunk Sewer and Sewage Disposal works are projected by Plainfield, North Plainfield, Dunellen, Fanwood and Scotch Plains, N. J. After lengthy negotiations representatives of the municipalities named have agreed on the general terms for coöperation in this project. The following agreement of cost has been decided on: Plainfield, 68%; North Plainfield, 25%; Dunellen, 7%; Fanwood and Scotch Plains to be cared for on a rental basis. Half of the cost of the necessary branch sewers leading from the several towns to the trunk sewer is to be considered a part of the joint scheme. No formal official action has been taken committing the several municipalities to the project, but a steering committee has been appointed, consisting of three representatives including the mayor from each municipality, for the purpose of taking the necessary action to carry out the scheme. George W. Fuller, 170 Broadway, New York City, is consulting engineer for Plainfield and North Plainfield. Andrew J. Gavett is city surveyor and street commissioner of Plainfield.

Methods of Combating Moss, Weeds and Burrowing Animals in Irrigation Canals*

BY W. M. WAYMAN†

The subject assigned is one which at first thought is of little magnitude to many operating men, yet the facts are that handling the weeds, moss, keeping the banks clean and preventing burrowing animals from working in the ditch banks is one which requires constant attention and never-ceasing vigilance.

MOSS—The moss question is of utmost importance. During the earlier months of the season moss does not ordinarily interfere with the successful operation of the canal, but where the ditch is supplied with spring or thermal waters, and as the weather becomes warm, the moss often grows very rapidly, especially where the water is so clear that the sun can shine through it and reach the bottom with some force. July and August are usually the worst months on account of moss. Moss sometimes grows in concrete sections and fluming, but rarely is it found in either of these places, and wherever the flume is dark colored or there is a bridge or shade across the canal in any way moss does not thrive.

Various systems of handling moss have been resorted to. Some will place a team on each bank and use an ordinary farm harrow to loosen it up on the bottom. Others will put in a flat boat and suspend a heavy drag from that. Another method is to take a chain and put weights upon it and haul it up stream. The most successful method, however, which I have observed is the use of a saw known as Ziemsen's weed-cutting saw. This saw is made of about the thickness of the ordinary hand saw, is about ⅜ in. wide and has hook teeth on each side. The saw is twisted so that it is turned clear around about once every foot. There are torpedo-shaped weights on this about every 4 ft. which hold it to the bottom of the canal. This saw is operated by a man on each bank and two ordinary men can cut from a mile to a mile and a half of moss in a day. It is usually necessary to place a screen across the canal in some convenient place below and have two men there to pull out all the moss which has been loosened up and floats down to the screen. This saw is handled by Asonert Bros., West Bend, Wis., and a 10-yd. saw complete costs $20. The saw alone is $1.50 per yard. Where many flumes are in use in the canal system it is desirable and almost necessary that you have a continuous flow and that wooden structures are kept full of water at all times. Where a system is free from flumes and wooden structures it is very desirable to turn the water out of the ditch for two or three days during the hot weather and the rays of the sun will kill the moss so that it does not often give trouble until the new growth begins to come to the surface of the water. It is no uncommon thing for moss to grow so that it will check up a ditch from 0.1 to 0.2 a day and will obstruct the flow to such an extent that not more than half the ordinary capacity of the ditch can be delivered. Where moss grows in concrete sections the most economical way to handle this is to turn the water out of the ditch and use a two-horse street sweeper. The moss can be killed from an ordinary tank by the use of blue vitriol, but in an irrigation ditch it is impossible to use a sufficient amount to be effective on account of the flow of the water, besides the danger to other vegetation and stock. In the large canals which have been recently built and those in the course of construction we have many in which moss will be a menace and no doubt some better way will be devised of handling this problem than we now are acquainted with. The velocity of the stream does not always prevent moss, but ordinarily it is found where the velocity is low.

WEEDS—On many of the new projects there is only a small proportion of the land in cultivation. Many of the settlers have come on their farms and have put in "prove-up" crops and much of the land is poorly cultivated and a portion is cropped one year and allowed to lie idle the next and usually there is very soon a large amount of weeds, Russian thistle, tumble weeds, sunflowers and mustard. As they dry up in the fall and the frost strikes them they loosen up at the ground and the wind blows them into the canal. Frequently ditch banks are lined with weeds of this character. One windy night will put so many in a canal that it will become blocked and often cause serious breaks. They will lodge at every structure and are an item that requires very careful watchfulness and sometimes great expense to avoid serious disaster. When the ditch banks are so lined with weeds of this kind it is almost impossible to do any work on the banks without cleaning them up thoroughly. In some localities the ditch banks have been cleaned, loosened up and sowed to rye. This rye will reseed itself and in some places has protected the ditch considerably from drifting sands and weeds and wherever rye thrives it will choke the weeds out; aside from this advantage the rye presents a much more pleasing appearance than weeds.

BURROWING ANIMALS—Various animals thrive in different localities and soils. In some localities the pocket gopher is a great trouble maker. Occasionally a badger will burrow in the banks. In other localities the muskrat is the animal

*Paper presented before the Boise Conference of Operating Engineers for Irrigation Canal Systems Located in Idaho, Oregon and Washington, November, 1911.

†President, Willow Creek Land & Irrigation Co., Brogan, Ore.

to be most feared. I know of no special rule that can be applied to handling these pests. My method is to go after them in every way and shape. Trap them, poison them, shoot them, or use any other method to get rid of them. The gophers are easily trapped and it is at the time when you are raising the water in the canals that danger generally occurs. Under some canals where I have been operating the ditch rider always carries a few traps and has numerous ones set at different places along the line. He often has with him a 0.22 calibre rifle and both do very effective work in proper hands.

DISCUSSION

C. H. Hagan, Watermaster, Minidoka Project, Rupert, Idaho: In connection with the moss problem I will say that on the Minidoka Project we have used the chain method to rid the canal of this weed. We use a heavy weighted chain which we drag up the canal, using a horse on either bank. In this way we can loosen the moss faster than two men can pitch it out of the canal at the check below, and I often have to stop proceedings and delegate an extra man to help them out at the check or go myself.

George Rinker, Watermaster, North Side Project of Twin Falls North Side Land & Water Co., Milner, Idaho: On the North Side Twin Falls Tract moss grew in concrete-lined sections having a depth of water of nearly 10 ft. and a velocity of 5 or 6 ft. per sec. I do not think that velocity has much to do with stopping the growth of moss; it is more a question of light. If the concrete-lined sections are painted black with an asphalt paint moss will not grow.

G. E. Harlan, General Manager, Twin Falls Canal Co., Twin Falls, Idaho: On the Twin Falls Canals we find it better not to remove the weeds from the canal banks any faster than is absolutely necessary, for, if we do, weeds blow into the canals faster from the adjoining farms. While the weeds remain on the banks of the canal they serve to catch other weeds and thus keep them out of the canals.

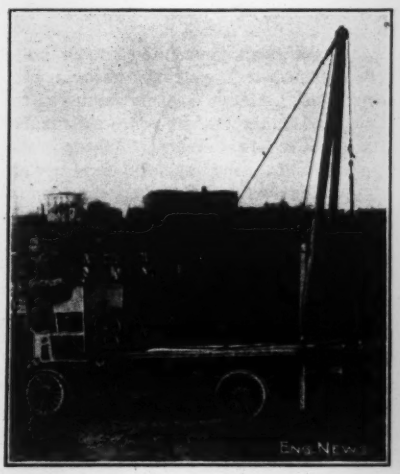
E. B. Darlington, Chief Engineer and Watermaster, Salmon River Project of Twin Falls North Side Land & Water Co., Milner, Idaho: On a project near Willows, Calif., a raft is used which floats in the canal. From this raft as it floats the weeds which grow along the banks of the canal are burned by means of a jet or blast.

R. K. Tiffany, Superintendent of Irrigation, Sunnyside Project, Sunnyside, Wash.: On the Sunnyside Project this year we inaugurated a scheme of moving a band of sheep up and down the canal. This was done through a contract with the owner of the sheep. The scheme worked fairly well, except that the contract under which I worked was not explicit enough and I could not control the movement of the sheep as much as I would have liked to have done. I wanted to see their ribs, but the herder would move the sheep on to a point where the feeding was better. Next year I expect to continue the arrangement under a little different contract.

J. M. Griffin, Superintendent of Irrigation, Umatilla Project, Hermiston, Ore.: On the Umatilla Project sowing of rye has been very effective in keeping down the weeds. This is seeded in the fall. It comes up in the spring ahead of the weeds and can either be mowed or allowed to reseed itself. The rye also keeps the banks from blowing away.

A Motor Truck for Setting Telegraph Poles

A special motor truck for digging post holes and raising the poles into position by power is shown in the accompanying illustration. It is claimed by the makers, the International Motor Co., of New York City, that with this machine practically twice as much work can be done at one-third the expense of the ordinary digging and pole-raising methods.



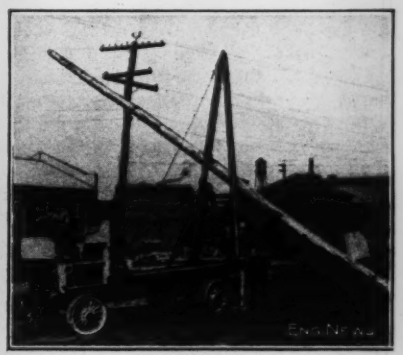


FIG. 1 AND 2. THE MACK POST-HOLE DIGGER AND DERRICK

This special motor truck is built up from the standard three-ton model of this company. The platform at the rear is reinforced with heavy I-beams and a single A-frame derrick is supported on the rear of the platform. Fig. 1 shows the post-hole drill supported from this derrick. The drill or earth auger is driven by a chain passing over a drum worked by the main engine of the truck. The auger is raised from the hole at about 2 ft. intervals, drawing the loosened earth with it, as shown in Fig. 1. When the hole is complete, the derrick is used to hoist the pole into position and lower it into the hole. The hoisting drum of the derrick is mounted on the same shaft as the drill-driving drum and is driven by the main engine of the truck.

In a test made at Glassboro, N. J., May 21, six post holes were dug and the poles set in position in the following periods of time: First pole, 27 min.; second, 30 min.; third, 45 min.; fourth, 45 min.; fifth and sixth, 25 min. each. It is explained that the time for setting the third and fourth poles was longer because of the time consumed in getting the derrick and pole into position under a string of 30 wires. These poles were 35 ft. in height. The gang for drilling the holes consisted of two men and the operator of the truck, and a total of five men were used to set the pole in position. It is claimed that under the usual method it would require one man one hour to dig the hole and a gang of nine men and a foreman would be required to raise it into position, the whole operation taking from 15 min. to a half hour longer than with the machine.

Mirrors at Street Corners to provide for the drivers of vehicles a view of the cross-street have been installed in at least two towns in England, according to a recent issue of the "Surveyor and Municipal and County Engineer." In Folkestone, there is an acute-angle street-crossing where one corner is built up close to the curb. On this corner is placed a 24x24-in. mirror supported on gas-pipe standards at such an angle that drivers of vehicles coming toward the built-up corner from either of the two opposite streets can see up the street at right angles to their path. The engineer-in-charge states that owing to the impossibility of motorists seeing any oncoming traffic several accidents and narrow escapes have occurred at that point. Since the mirror has been fixed he has not heard of anything approaching an accident. The damp, mist, rain or frost have no ill effects on the mirror, which is occasionally cleaned by a passing lamp lighter when cleaning his lamps.

At Malmesbury, in Wiltshire, a mirror 5x8 ft. in size supported on standards so that its top is 15 ft. above the street occupies an angular position at the apex of a closed right-angle curve. The engineer-in-charge says, "The mirror requires scarcely any cleaning; only a wipe-over once in about three months. I can, with confidence, recommend it."

Winnipeg Municipal Electric System*

By W. G. Chace†

The city of Winnipeg, Manitoba, has now partially completed a power-supply system comprising two-60,000 volt transmission lines leading from a 60,000-hp. hydro-electric development to a receiving station in the city and four transformer substations connected with the receiving station and with the customers by underground cables. Funds were secured at a low interest rate which made possible an unusually substantial construction and a decrease of annual maintenance costs without raising investment charges.

*Based on a paper before the Canadian Society of Civil Engineers, Jan. 24, 1911; revised to date.

†Smith, Kerry & Chace, Engineers, Toronto, Ont.

The city of Winnipeg, with suburbs, has a population of approximately 200,000 and covers 13,000 acres. It is practically the port of entry for all Canadian manufacturers to the four great Western provinces of Canada and is the point of outlet for eastward exportation. It is a point through which pass all three Canadian transcontinental railroads, and is also entered by two railroads from the South. It is located at the junction of the Assiniboine and the Red Rivers and is now connected by navigable water to Fargo, N. D., and to all points on Lake Winnipeg in Central Manitoba. The immigration to the Western provinces now reaches an annual dimension of about 300,000 people, and there seems little likelihood of early diminution.

On such facts, the citizens felt justified in their optimistic outlook when, in 1906, they voted for the immediate expenditure of $3,250,000 for a generating and transmitting system, and subjected themselves to a gross expenditure in the neighborhood of $6,000,000.

The chief reasons for this decision were (1) that the sources of supply for electricity and gas were at that time in the hands of a monopoly which also controlled the distribution system within the city, and (2) that the source of hydraulic supply at that date developed by the private corporation was not of such dimension as to insure a sufficiency for more than four years. Until 1906, this concern, the Winnipeg Electric Ry., depended upon a 6000-kw. steam station; in that year the company put into operation its Lac du Bonnet hydro-electric plant, with a normal rating of 14,000 kw. and a maximum capacity, under 39 ft. head, of about 20,000 kw. In 1911, the date of completion of the municipal plant, the demand upon the company's stations had increased to approximately 25,000 kw., and in the spring of that year the company commenced the construction of a 9000-kw. steam-turbine station in Winnipeg. This was put into operation in December last.

The first move by the citizens of Winnipeg looking to the control of the municipal supply was made in 1903, when tenders were called for a supply of 5000 hp. These tenders were not accepted and in 1905 engineers were asked to examine for the city certain available waterfalls on the Winnipeg River; on the basis of these reports the citizens, in June, 1906, voted for the expenditure of the above mentioned sum. Designs were made, and in August, 1907, tenders were asked for the construction of a plant at Pointe du Bois (Thirty-Foot Falls), about 90 miles from the city by railroad and trail. No contract was let at that date, but in the following spring work was begun on the construction of 24 miles of standard-gage railway necessary to connect the site with the terminus of the Lac du Bonnet branch of the Canadian Pacific R.R. In January, 1909, contracts were let for the construction of the hydro-electric works and the transmission line, and later in the year for other necessary construction and equipment. The plant was completed and put into service Oct. 16, 1911.

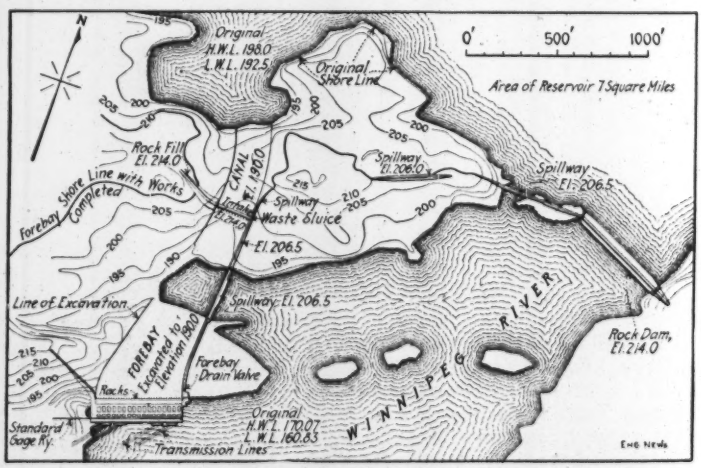


FIG. 1. POINTE DU BOIS POWER DEVELOPMENT ON THE WINNIPEG RIVER

The undertaking consists of: (1) A 60,000-hp. generating station; (2) a 77-mile 60,000-volt transmission line; (3) a terminal station in the city, reducing potential to 12,000 volts; (4) an underground cable distribution to substations; (5) four substations where the potential will be reduced to 2200 volts a.c. and (or) 550 volts d.c.; (6) a secondary underground and overhead distribution to customers.

DRAINAGE AREA—The Winnipeg River, with its tributary the English River, drains a portion of northern Minnesota, northwestern Ontario, and eastern Manitoba, in all a watershed of 52,000 sq.mi. This watershed is nearly all of Laurentian character, and has a considerable proportion of forested area untouched by the lumberman. Many small lakes are to be found in all districts, and the river proper passes through several, of which the largest is Lake of the Woods. The gross lake area is 5650 sq.mi., and that of the Lake of the Woods is 1200.

The drainage area has an average annual precipitation of 18 to 25 in. The average yearly run-off of the watershed above Kenora (27,000 sq.mi.) is (W. Thibaudeau, C. E.; report dated Mar. 24, 1908) about 22,000 cu.ft. per sec., the range of average yearly run-off for the entire river being given as from 29,000 to 39,000, determined from precipitation records for the years 1896-1907. This corresponds to an average proportion of run-off to precipitation for the four years of 37%. However, accurate records of precipitation within the watershed are not available. From the records of water elevations, at Pointe du Bois and from actual gagings by the city the minimum flow for the period covered, 1907-1911, is estimated at 13,000 cu.ft. per sec., and the maximum at 55,000. Lake of the Woods could be so controlled as to store as an average 70% of the entire yearly run-off, and such manipulation of the dam there as will permit of the maximum use of the water power at Kenora will have very desirable effects at Pointe du Bois.

The entire flow of the river can be

reasonably utilized at four sites—Pointe du Bois (or Thirty-Foot Falls), Slave Falls, Grand Bonnet, and Silver Falls—under heads of 45, 25, 47 and 43 ft., respectively, in each case by "drowning*" smaller falls upstream. At Pinawa (the present development of the Winnipeg Electric Ry. Co.) on the east branch, and at Seven Portages on the west branch—the energy of a portion of the discharge is available under heads of 39 and 30 ft., respectively.

The engineers of the city of Winnipeg, reporting in 1905 on three sites, chose that at Pointe du Bois as the most desirable then available. The natural drop was from 33 to 28 ft., depending upon the stage of the river, and the dams as now constructed have the effect of increasing the fall to 47 ft. and 44 ft. at low- and at high-water stages, respectively.

There was originally a stretch of smooth water, eight miles long and about 3600 acres in extent, above Thirty-Foot and below Lamprey Falls. This acreage has been increased to nearly 6000 with great advantage to the city's plant. The entire energy of the average minimum flow of the stream is about 55,000 hp., and on this pondage it would be easily possible to carry a daily peak of 100,000 hp.

HYDRAULIC DEVELOPMENT—Fig. 1 shows the general works, giving a very fair idea of the natural surfaces before the beginning of the work. The stream falls over the two rock ridges, the greater drop being at the lower ridge. The problem of concentrating the entire increased head at the site chosen was a simple one, involving chiefly the excavation of a canal across the west-shore ends of the ridges and the construction of a retaining wall along the east side of the canal so made. To increase the natural fall, river walls and a dam were

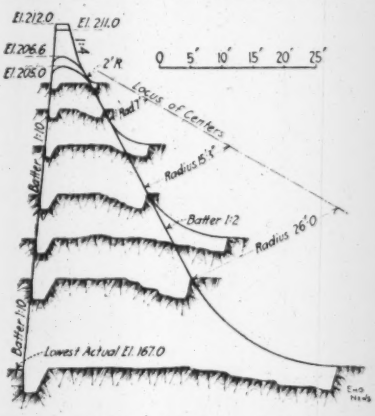


FIG. 2. TYPICAL SECTIONS OF OVERFLOW AND RETAINING WALLS; POINTE DU BOIS PROJECT

this fixed elevation, and there is a gross length of 1500 ft. of this weir in four sections: 550 ft. on the original high-water course at the crest of the falls, 480 ft. on the earth-covered point of land forming parts of the upper ridge, 245 ft. on the canal wall immediately above the intake or control gates, and 225 ft. on the same wall inside those gates. A weir for the disposal of waste is located at each side of the canal at the power house and a waste sluice is placed in the forebay wall immediately above the control gates. The south end of the canal is occupied by the power-house structure, from the west end of which a wing dam extends to high ground.

River wall No. 1 occupies a portion of the crest of the falls which was covered with water only at flood stages of the river. River wall No. 2, upon the originally dry point of land, was built (and made of concrete) because for a considerable portion of the ridge the rock is of low elevation, and the possibility of

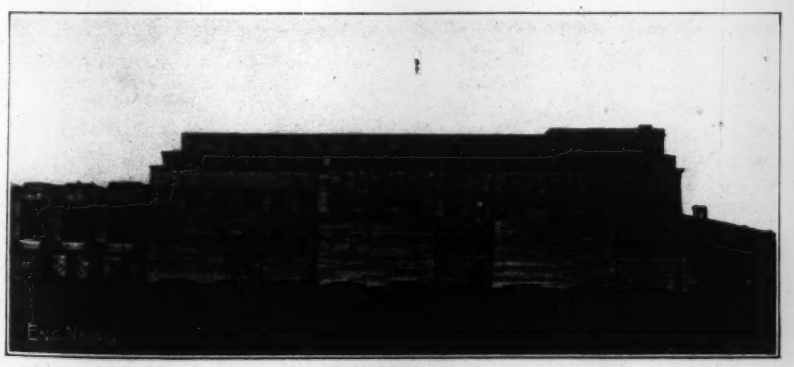


FIG. 3. WINNIPEG MUNICIPAL HYDRO-ELECTRIC STATION

necessary, and the elevations of these were so chosen as at once to assure the desired head of water, and also the discharge of flood waters without over-topping certain fixed elevations. The crest of the principal weirs is 7.4 ft. below the earth overburden being sometime washed away would make likely the loss of considerable head by the drawing down of headwater level. It was built of overflow section, and with crest at standard overfall elevation, that is, minimum headwater level. The portion of the forebay wall inside the canal with crest at this elevation is provided to insure a surface-cleaning current within the canal and a constant inflow through the control gates.

Considerable trouble has been experienced in these northern climates with loss of heat through the walls of the canal at the ends of the power house, to such an extent, that the head gates in the first and last inlets would freeze up. To prevent, if possible, this contingency, the section of forebay walls next the power house has been increased, and a series of air chambers have been provided, connected together and to the inter-connected chambers beneath the apron, the temperature of the air in which is not likely to fall below 32° F. These air chambers are extended up canal past the overflow sluices in an effort to prevent the closing up of these sluices by the formation of ice thereupon, a not uncommon occurrence. The operation of this plant during the winter of 1911-12 has indicated the efficacy of this scheme.

Experiments during the past winter have proven that, by the suspension of twenty-five 50-watt lamps, or equivalent resistance, just above water level, each headgate can be kept free of ice even with air temperatures of —40° F.

Fig. 2 shows the cross-section of the standard wall and overfall weir. All foundations are on undisturbed native granite, scored and roughened to insure bond and water-tightness. The specification for these foundations follows. It was lived up to consistently.

> For these sections there shall be made such excavations of rock as shall be necessary to permit, at the heel, the construction of a jointing barrier or apron of concrete, at least as deep as shown in the respective cross-sections (or deeper if necessary) to prevent the inlet of water into seams of rock below the wall); at the toe, the formation of a shoulder of rock against which the horizontal thrust of the wall may be taken up; the depth of this shoulder should be at least as great as that shown in the respective sections of the wall on the drawings.

Careful study has been given to the velocity of the water at critical points. Fortunately, above the intake, the river is very broad and the mouth of the bay at the head of the canal is so wide that the water will approach the canal slowly, accelerating as it nears the control inlets. Through these inlets, and under full load conditions (60,000 hp. delivered from generators) it will be moving at 6.4 ft. per sec., but will emerge into a gradually widening passage until at its crossing of the greatest section of the canal forebay, it is moving very slowly. Thence its speed slightly increases, to 1.3 ft. per sec. through the outer piers of the rack room of the power house, to 1.7 ft. per sec. through the inclined steel racks, to 2.8 ft. per sec. through the wheel-pit inlet, 20 ft. per sec. into the turbine runner, and decreases to 8 ft. per sec. at the neck of the draft tube and

3.3 ft. per sec. at the exit of "seal" of the draft tube.

The effort to properly control these velocities has resulted in several unique features of power-house construction to be observed in a study of Fig. 3, showing a cross-section of the power house. Along the north face of the building, where the natural rock surface slopes sharply southward, a huge apron has been built consisting of a 16-in. sheet of reinforced concrete upon numerous supporting walls. This upward sloping apron causes a gradual decrease in the cross-section of the path of the water. It also, incidentally, is a gravity dam securely tied to the series of wheel-pits to the south of it, and is a considerable element of the dam. Upon the apron sits the rack structure. The rack bars are 45 ft. long on the rake, and their supporting structure is designed in 7-ft. bays, at whose junctions are placed the trusses, each consisting of a main rafter and two struts to a common foot-plate. By this means a minimum metal section is opposed to the current of entering water. The importance of low rack velocities to satisfactory operations of a hydraulic plant can hardly be over-estimated, as, besides diminishing a certain loss of head there, this characteristic minimizes the tendency for débris to accumulate and choke the racks. The inlets to the wheel pits are liberal, each being 16x20 ft. clear, with rounded piers between them, and each with rounded entrance into the turbine chamber. The draft tube, a 10x15-ft. oval at the intersection with the turbine-pit floor, expands to 13x23 ft. in such dimensions as make the velocity curve smooth throughout its length.

The contractor was very successful in an effort to make the apron under the rack structure water-tight. This apron was built with reinforcement of ¾-in. twisted-steel bars interlaced. Before filling the canal the precaution was taken of applying two coats of cement grout containing a solution of soft soap and alum. There is a head of 30 ft. upon this sheet of concrete, but the leakage consists only of isolated drippings almost certain to be stopped entirely by the accumulation of silted and of chemically formed deposits.

The quantities of water to be handled in this plant are unusual, and the feature most noticeable as a result of this fact is the huge size of the power house.

The present building, accommodating equipment of a rated capacity of 32,000 hp., is 250 ft. long, 150 ft. wide and 100 ft. high. The general arrangement is seen from Figs. 4 and 5.

TEST FLUME—On account of the desire to make a satisfactory test of the water turbines, a device was demanded for measuring the water passed, and for this purpose a measuring flume has been installed as an extension of the tail race of the spare unit. It is the intention to measure the velocity of the water passing through this flume by observing the movement of a weighted vertical close-fitting diaphragm, suspended from a raft which is allowed to float with the current.

This flume is shown in Figs. 5 and 6. Two thin concrete walls rise from the floor of this tail race to the elevation of flood waters, and extend outward from the face of the building a distance of 55 ft. The rock floor of all the other main-unit tail races was excavated to a 6% grade rising from beneath the "seal" of the draft tube to the intersection with natural rock surfaces or, in case that surface were at too great an elevation, then to within a safe distance from the coffer-dam. The floor of the test flume, however, was made level throughout, beginning at the standard grade at the

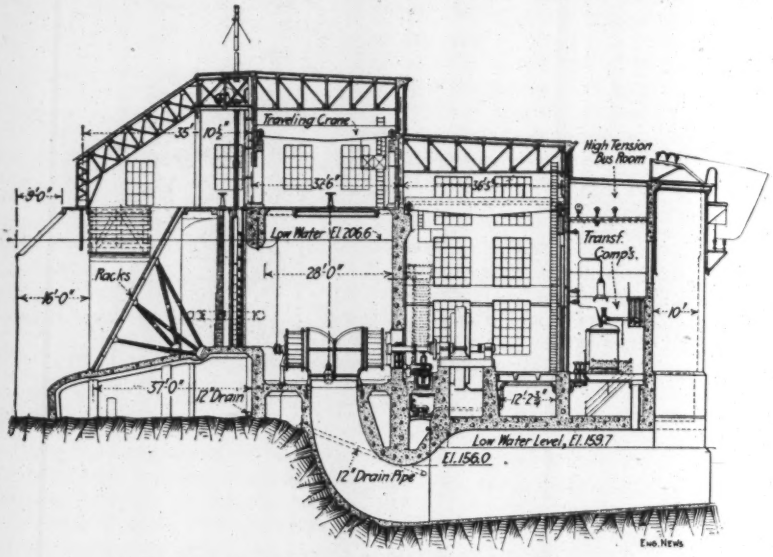


FIG. 4. ELEVATION OF POINTE DU BOIS STATION

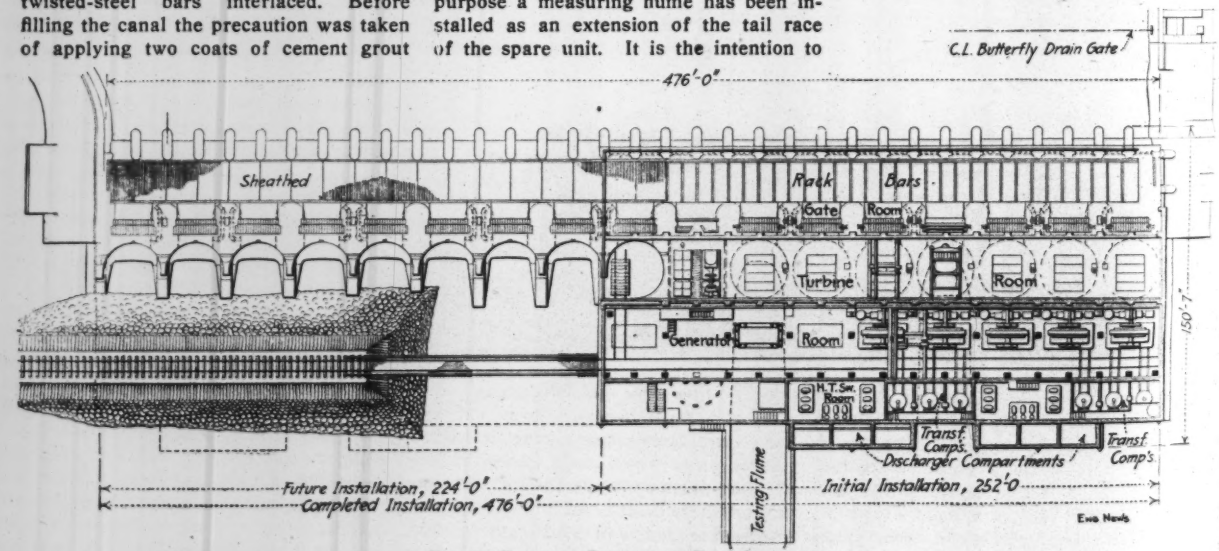


FIG. 5. PLAN OF POINTE DU BOIS STATION

outer face of the south wall of the power house. This will provide a constant cross-section in the flume at all elevations of tailwater surface. Upon oak inserts flush with the inner face of the flume walls—one pair *AA* near the power house, another pair *BB* 4½ in. from *AA* and another pair *CC* 25¾ in. from *BB*, electrical contacts are to be secured to indicate on a recorder the instant at which the raft and diaphragm passes a contact point.

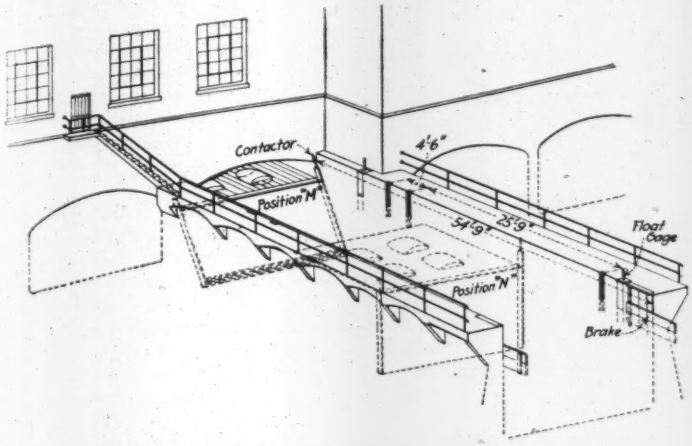


FIG. 6. ISOMETRIC VIEW OF TESTING FLUME

The raft will be drawn to the station wall and held fast until the load on the turbine is constant as desired for the test. The diaphragm will then take up an inclined position in order to allow the discharge to pass. When the load conditions are satisfactory, the raft is released and soon the diaphragm is vertical with the raft moving at the velocity of the water. Should the pointer above the raft indicate that the diaphragm is not yet vertical when passing the contacts *AA*, that reading is neglected and only the time of passing *BB* and *CC* is considered.

Experience will soon train the observer to accurate use of the device, which should prove satisfactory since the leakage past the diaphragm can be but a very small percentage of the entire flow. The outlines of this method of water measurement were described to the city's engineers by the manufacturers of the turbines who had used it in European installation with no little success. Owing to the lateness of the season the hydraulic efficiencies of the turbines were not tested during 1911, but it is planned that these tests shall be made after the break-up of the winter when there shall be no ice in the river to interfere.

STATION—Almost the entire construction is of concrete and steel. Timber is used only (1) in the stop logs, (2) in sheathing the rack structure which is used as a gravity dam in the gap between the present power house and the wing dam, and (3) in some weather curtains suspended from the outer walls of the rack room.

All weirs and river walls, the power-house foundations, and most of the walls of the superstructure, were built of plain concrete. The wheel pits, the floors of the apron, of the wheel pits and the main building, and all galleries and roofs were made of reinforced concrete. The wheel pits were designed each as a self-supporting reinforced-concrete tank, thus permitting the reinforcement to be so disposed as to take up definitely known tensions, beam action being avoided as far as possible. About the inlet to each wheel pit and about the large shaft opening in its south wall, the reinforcing steel was bent, or it was run deeply into the adjacent concrete masses at the corners of the chambers and anchored. The reinforcing steel generally usesd was twisted square steel bars; that in the roofs, floors, and plaster walls was a special expanded metal. All beams were fireproofed with concrete, metal lath being first wrapped about the bottom flanges.

Temperature and crystallization effects in the concrete were taken care of in two ways. The river walls were built in alternate sections of 50 ft., the ends of the completed sections being painted with two coats of heavy asphalt before the intervening sections were built. This has been generally successful but, in certain shallow sections, subsidiary vertical cracks of small importance have been discovered at sudden changes of grade in the profile of the foundation of the wall. The power-house foundations comprise, besides the series of draft tubes, a series of flat tail-race arches upon supporting walls, tapered in plan and which were built in pairs of arches; the two adjacent spans, built as a unit with a mid-wall, are resting, at their "flying ends," upon asphalt painted skewbacks formed upon alternate tailrace walls. The contraction joints are thus 56 ft. apart. By this means, the use of reinforcing steel in these arches was avoided except in the most westerly arch, which is designed as a beam. In the transverse elevation of the building, the foundations were separated into three portions, (1) the arrester bays, (2) the transformer and generator room, and (3) the turbine and rack rooms; this was done by use of two vertical expansion joints running the entire length of the building. Above the tail-race arches, vertical parting places, asphalted and keyed with wooden strips, were used in the main walls with considerable success in an effort to avoid unsightly cracks, which are almost sure to appear in long concrete buildings unless carefully provided against.

All walls under the apron, the shells of draft tubes where these project above the natural surface, and certain other portions of the work were provided with "contraction steel" to the extent of ⅓% of the section.

The headgate for each wheel pit is a steel frame, with Georgia-pine sheathing. It is designed to work upon rollers, and at each end a floating pinion meshes into a pair of racks, one on the gate, and one on the guide. The stems of the gates are lifting screws 40 ft. long, which rise through motor-driven nuts placed in the roof of the gate room. The mechanism is arranged for the lifting of four gates by one motor drive, jaw clutches for each gate being supplied along the main shaft. The gate is made water-tight at the sides by means of hinged cotton-covered wood rods, and the bottom of the gate is shod with oak for contact on a steel seat.

POWER APPARATUS—The problem of choosing the most desirable type and dimensions of generating unit required careful study. The huge power capacity available, along with the large prospective market, pointed toward the use of as large a unit as possible, but the moderate head and consequent large body of water to be handled for each large unit, set a definite limit upon the dimensions; the desire for a compact equipment pointed in the direction of the highest speed permissible. The resultant choice was a two-runner 5200-hp. turbine of high specific speed, coupled to a three-phase 3000-kw. generator. This unit will pass 1250 cu.ft. of water per second at maximum output under a net head of 45 ft. running at 164 r.p.m. This quantity of water can be disposed of without unreasonably high velocities in inlet or tail race.

The use of a four-runner unit would have permitted a machine of 10,400-kw. capacity, but there were the objections of still larger water passages and of a less compact and satisfactory governing mechanism, with very little to be gained in the gross dimensions of the power-house building and nothing to gain in the cost of developing the power site to its full capacity.

FIG. 7. HEAD GATE ROOM AND RACKS

It is planned to handle three of these generators as one operating unit, and the switching is so arranged, though provision has been made for the isolation of any machine and, to a limited extent, for the re-arrangement of the groups. This will make 9000 kw. the operating unit, and there will be five such in the complete installation, besides one spare generator and turbine.

The turbines have forged-steel plate buckets, with cast-iron hub and rim. Each unit is horizontal in an open wheel pit, with an elevation above the floor and a clearance at the ends so that the entering water has moderate velocities, and free access to the entire gate periphery. The two runners discharge axially into a common draft chest, and thence into a liberally designed draft tube, all changes of direction of flow being gradual and smooth. The shaft has three bearings, two of which are lubricated with grease constantly forced in by a pump for each bearing and driven from the turbine shaft; the third, in the wall-frame casting,, is of the ring-oiling type. Under an output test one turbine unit developed 5800 hp. with 46 ft. head. The guaranteed efficiency is 84% at full load.

Flutter gates are operated by means of two gate shafts set in the horizontal plane of the main shaft. These are controlled by oil-driven pistons in cylinders ("servo-motors") set immediately below the main shaft of the turbine on the power-house floor. The oil pump and governor are conveniently located between units along the line of the servo-motor cylinders.

Current is generated at 6600 volts and 60 cycles by revolving-field alternators. Each rotor is built up of two cast-steel flywheels with a one-piece rim and a four-piece hub shrunk together with steel rings. The field is made up of 44 poles dovetailed and wedged into the rim. The armature coils are formed and dropped into open stator slots—three per pole per phase. The generator weighs 155,500 lb., of which 57,300 lb. is in the rotor and 34,500 in the base and bearings. The guaranteed and proven electrical characteristics are: full-load efficiency, 95.2%; regulation, 8¼% at 100% power factor; temperature rise at full load and 100% power factor, not to exceed 35° C. On standard ratings the unit would be marked as of 4000 kw. capacity. Two water-driven 250-kw. 125-volt exciters, direct driven by water turbines, are provided, though it is planned to furnish ultimately also two motor-driven exciters of the same unit capacity, and the immediate installation of one such unit has been recommended.

Single-phase 3000-kw. transformers are used, so that a bank of three make a unit corresponding to one operating unit in the generating equipment. This arrangement is desirable from the point of view of insurance, continuity, flexibility, and simplicity. The transformation ratio is normally 10 to 1, but taps provide a range of transmission-line potential from 53,000 to 72,000 volts.

The transformers are oil-immersed and water-cooled. Each is set in a separate concrete-walled compartment, entrance to which from the power-house floor is guarded by an iron-clad door. The case is of boiler-plate, set upon a cast-iron base. The water-cooling coils are of brass tubing. Besides a complete system of tanks and pumps, a dehydrator is provided.

There are two electric traveling cranes —one serving the turbine room and one the generator room. The runways of the former, a 20-ton crane, are of concrete, built integrally with the walls of the room; the north girder in the generator room is also of concrete to carry the 40-ton crane. The load of the truck is distributed along the girder by cushions of steel plate and oak under each rail.

A compressed-air equipment is installed, and a line of pipe runs the full length of the generator room, with taps into the turbine and gate rooms.

The generator, transformer and transmission-line circuits are all handled from a control gallery, opposite the exciter bay. Here are instrument pedestals with remote-control equipment, those for each operating unit standing isolated about the operator's position.

The low-tension (6600 volts) leads and busses are all isolated by barriers on the main floor of the station; the genera-

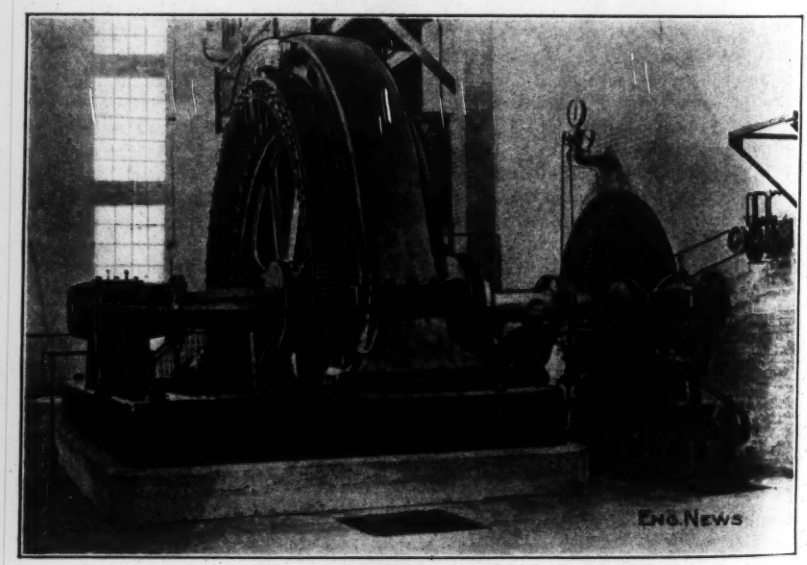


FIG. 8. 3000-KW. GENERATOR

tor and transformer oil switches are here in two separate compartments, one for each 9000 kw. of capacity. The high-tension wiring is all in the upper portion of the switching bay, and the high-tension oil switches, one per operating unit and one per line, are located on the gallery, those for each unit being in a separate compartment. This high-tension wiring is laid out for a separation of 48 in. between wires, and there is a clearance of 24 in. between each wire and ground.

Each outgoing wire of the transmission circuit has a separate concrete compartment. Inside each compartment is provided an electrolytic arrester, with its horn gaps and operating mechanism.

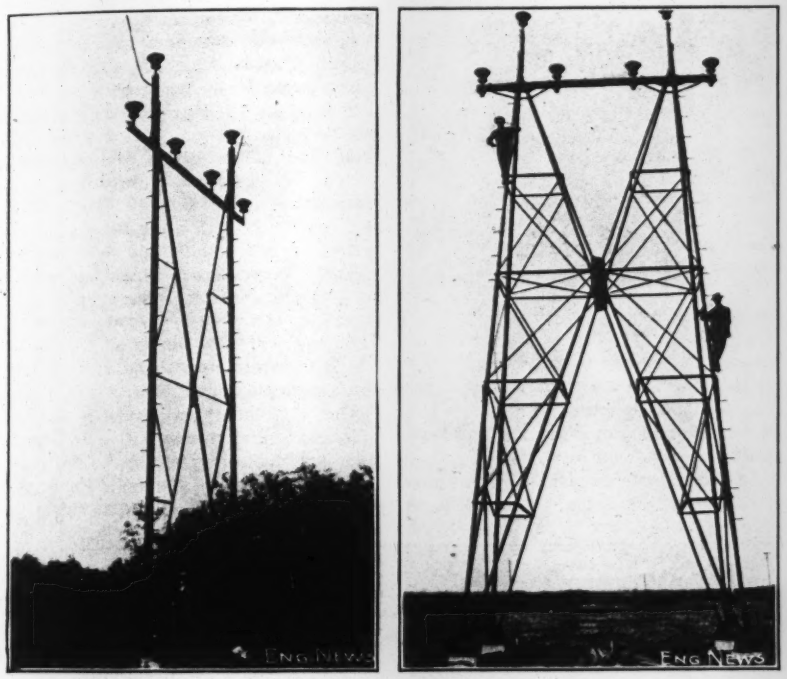


FIG. 9. TRANSMISSION-LINE TOWERS

Upon the roof beside each wire anchorage a set of horn gap arresters is placed. The lines leave these compartments of the building through special "hoods" of reinforced-concrete suspended from the wall. These hoods are open below, but the inlet through the wall is protected by use of a special entrance insulator.

TRANSMISSION LINE—The transmission line is built over a private right-of-way, 100 ft. wide and 77 miles in length. It traverses a varied country, the eastern section being typically Laurentian rock and muskeg, the western section crossing a prairie and farming country, of which several miles are heavily wooded. At present one line of double-circuit towers and a separate telephone line have been built over the right-of-way. When the load increases sufficiently a second line of steel towers will be erected. A patrol road 12 ft. wide has been built next the telephone line, and much of this road has had to be corduroyed.

For the telephone line a single copper circuit is carried by a single crossarm on wooden poles so placed that when the second line of transmission towers is completed the telephone wires will be 30 ft. from the nearest power conductor. The telephone circuit is transposed in a continuous helix of four turns per mile to eliminate inductive interferences. At every mile an iron jack-box is placed on the pole—the linemen having equipment to call the line terminals. There are 15 telephone booths at convenient points, and in them is a cot, stove, workbench, standard wall telephone set, disconnecting switches for the telephone line, an insulating stool, and supplies for both transmission and telephone line. At certain of the more isolated booths there is a stable.

The towers are of two general types —"braced" and "flexible." In the former group are the standard braced, transposition and angle towers, 50, 50 and 56 ft., respectively, and the special towers for river crossings; in all nine types of these towers were used. Two types of flexible towers were used, one for firm soil and one for muskeg or swamp construction. These towers are 42 ft. high. The braced towers are generally spaced 1200 ft. apart, this distance varying to suit the profile of the route or to fit the road allowances crossed. The longest span on the line is 939 ft., and is at the Winnipeg River crossing. The flexible towers are placed between braced towers as intermediate line struts.

The first braced tower assembled was submitted to the following series of tests in May, 1909, at the shop of the manufacturers in Winnipeg: across the line of the circuits 6200 lb. was applied to one end of the crossarm, which is 43 ft. above the ground, representing a wind load of 1040 lb. per pin; along the line a load of 7200 lb. was applied, the equivalent of 1200 lb. per pin. The moderate deflection in each direction indicated the satisfactory nature of the design.

The flexible tower is designed to resist the same transverse line forces, but it is good for only about 480 lb. gross at the crossarm in the plane of the transmission line. The 2-ft. pin of 2-in. standard wrought-iron pipe bearing the insulator is designed to be the weakest point in the wire supports, and this is good for a pull of 900 lb. at the wire before sign of failure, and under test withstood 1500 lb. just before breaking. On dead-ending at river crossing and railway crossing towers solid pins of the same diameter are used. All towers are painted.

The tower footings are of two classes, one for firm soil designed as a concrete block 7 ft. in the ground, and the other for unfirm foundation consisting of a hollow reinforced-concrete block erected and grouted in place upon piling. On rock, the footing, if shallow, was anchored thereto. All towers are carefully grounded.

Each three-phase circuit is of 11,250 kw. capacity. The conductors are aluminum 19-strand 278,600 circ.mil cable on 6-ft. centers. Each strand was tested before cabling and a high elastic limit and ultimate strength were assured, namely, 14,000 to 15,000 and 24,000 to 29,000 lb. per sq.in., respectively. Joints in stringing are made with 18-in. elliptical tubular sleeves, three complete twists being given. Test of a sample joint indicated that it is as strong as the cable itself. In stringing great care was exercised to prevent contact of the cable with the steel or rocks; it was pulled over each tower as the reels were unwound, running on a stout pine crossarm, with wooden pins, secured upon the channel-iron crossarm of the tower.

The sags were carefully calculated and checked, and were formally approved by the cable manufacturers before beginning work. A set of curves of sags for varying spans and temperatures was prepared and a simple set of auxiliary curves was laid out for determining the proper adjustment of the standard sag for differences in the elevation of consecutive towers. Each span was sighted in separately as the tying gang proceeded. The cable is strongly fastened to all towers with a tie consisting of 42 servings of No. 2 B. & S. soft-drawn aluminum wire on each side of the insulator; two wires are used. This gives a wrapping sufficiently long to protect the cable against injury from any electric

FIG. 10. WINNIPEG RECEIVING STATION

arc which might follow a discharge to ground over the insulator. Upon the insulator and under the cable is placed a "U" shaped aluminum plate or cushion ⅛ in. thick, which is afterward cramped together over the cable in place. The principal object of this is to afford protection to the cable against the confined electric arc which would follow a puncture of the top of the insulator.

Each circuit is transposed six times between the power house and the Winnipeg terminal, making two complete spirals. The wires of similar phase relation have the same relative places in both stations.

The line is subdivided at two disconnecting switch towers, one at Lac du Bonnet and one near the crossing of the Canadian Pacific Ry. east of Tyndall, making three sections, respectively 23, 29 and 25 miles long. Each tower is a double structure made of two standard angle towers with connecting members and bearing an insulated operating platform between. The line is dead-ended both ways and in the gap in each circuit is placed a mechanically operated insulated disconnecting switch so designed as to open the three wires of the circuit at the same instant. The blades all move in one horizontal plane and the device is operated by means of a chain reached from the platform below. It is planned to keep one resident patrolman close to each of these towers, so that he can be called by telephone to open a switch should such be desirable for repairs. A set of jumper connections was designed for use on the disconnecting towers to permit use of any one of the three sections, or either of the two circuits in conjunction with the other on consecutive sections.

The insulators consist of four porcelain shells, held together and to a malleable-iron threaded pin top with portland cement. The top diameter is 8½ in. and the overall height 13½ in. The assembled insulators withstood, under factory test, 195,000 to 203,000 volts dry, and 130,000 to 140,000 volts under a precipitation of 1 in. of water in four minutes; under unfavorable weather conditions they withstood 167,000 volts dry test and 119,000 volts wet test. All insulators delivered to the line were inspected at the factory, and tested electrically in individual parts and after assembling. After acceptance they were shipped, three in a crate, ready for teaming to the tower.

TERMINAL STATION — The terminal transformer station in Winnipeg is located at the river front on Point Douglas, occupying the north end of a city block. It was designed to receive the entire capacity of the generating plant. The building will be symmetrical about a central office section, but only the east wing and office section are now completed, accommodating three banks of transformers, 24,300 kw. The building is of red brick, with white stone trim, and rests upon a foundation of concrete upon piling. A spur track leads into a portion of the building, where an electric traveling crane can unload shipments. This bay will also serve as a room in which transformers can be disassembled for examination and repairs.

The equipment here consists entirely of static transformers, with line protective and control apparatus. The high-tension lines enter the building on the north through concrete-hoods, similar to

FIG. 11. HIGH-TENSION SWITCHING ROOM, WINNIPEG RECEIVING ROOM

three on the south face of the generating station. The electrolytic arresters occupy each a separate brick compartment upon the upper floor of this building immediately within the wall entrance. The high-tension wiring is all exposed in this station also, and the same clearances are observed as in the generating station. The high-tension switches and series transformers are on this top floor. (See Fig. 10).

Six oil-immersed water-cooled step-down transformers are installed for the present, though the present building can accommodate nine. These are identical in pattern with transformers at Pointe du Boise, but of 2700 kw. capacity. They step down to 12,000 volts from line potential of 60,000 volts delivered; suitable taps are provided on each winding for varying this ratio. They occupy individual brick compartments on the ground floor, and the compartments are separated by a brick wall from the low-tension switch room alongside the entire length of the building. The 12,000-volt wiring of this station is all inclosed in barriers. All switches are of the oil-immersed, electrically operated type, the energy supply for their operation being insured by use of a 100-amp.hr. storage battery with a 10-kw. motor-generator set. This station has a complete outfit for cleaning and drying the transformer oil.

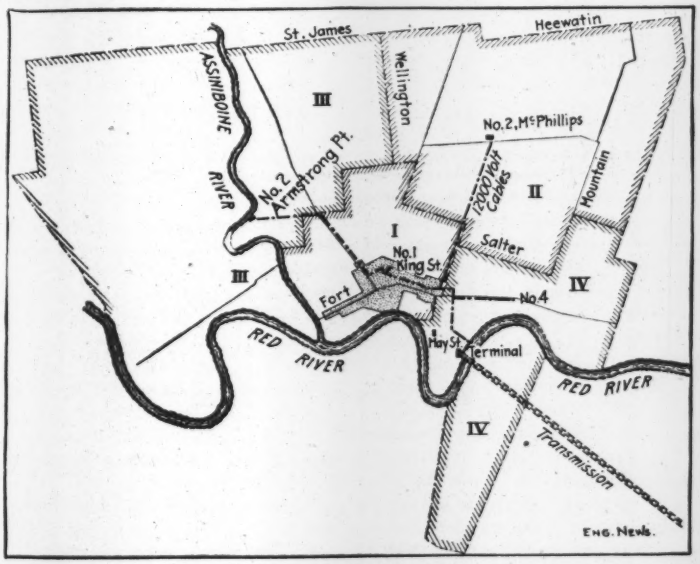


FIG. 12. WINNIPEG DISTRIBUTION SYSTEM

LOCAL DISTRIBUTION—Energy is distributed underground at 12,000 volts by lead-covered paper-insulated cables. The distribution scheme involves the early construction of four substations. Two of these have been completed and put into service; Substation No. 1 on King St., near Notre Dame, in March, 1912, and No. 2, at McPhillips St. and Higgins Ave., in July, 1911. No. 1 has now 3000 kw. in static transformers (with room for 3000 kw. more) and 1000 kw. in synchronous-motor three-wire-generator rotary converters. From here, direct current is supplied at 225 and 550 volts for elevators, printing presses, etc.; the principal output, however, is alternating current on 2200-volt feeders for the transformers of 110- and 220-volt street lines.

In Substation No. 2 there is 3000 kw. in static transformers, but no provision for direct current. Two 12,000-volt feeders are handled at this station. No. 3 will probably be located on Armstrong's Point to serve the principal residential district, while No. 4 will be in the North End. There is a temporary installation of 1500 kw. of the No. 4 substation equipment, in the receiving station, to serve the domestic requirements of the section and the city street-lighting station on May St.

The 500-kw. oil-immersed self-cooling single-phase transformer has been chosen as the standard unit of equipment for transformation from 12,000 to 2200 volts. It is as large as is desirable for this type of apparatus and the type requires no complex auxiliary systems for its continuous operation.

By a city ordinance, all wires within a specified downtown area must be placed underground; construction of distributing conduits in certain portions of this area was carried on in 1911 to the extent of 300,000 duct feet of conduit and 27,000 ft. of iron-pipe laterals. The minimum number of ducts in any run will be four and these will provide accommodations for (1) street-arc circuits, (2) low-tension alternating-current mains, and (3) direct-current mains, with (4) at least one spare duct. Certain runs are designed to accommodate feeder cables as well. These conduits are being constructed under special by-law of 1909, which furnished funds and provides for rental of the space therein. An investment of approximately $1,000,000 has already been made on the distribution system, which now covers a large proportion of the streets.

In the 12,000-volt conduit connecting the receiving station with substations, single vitrified fireclay duct, with an absorption of less than 3%, was used and ducts were separated each way with 1½-in. portland-cement mortar. The standard spacing of manholes is 350 ft. This conduit is reserved for high-tension cables, as it is not intended to build overhead leads at 12,000 volts within the city. Distribution conduits differ from these in that (1) the mortar will be omitted from between adjacent ducts, (2) manholes are at street intersections, and (3) service boxes are placed at frequent intervals.

A load of 2500 kw., consisting of the power required for city lighting and pumping was taken on Oct. 16, 1911. Since October the wiremen have been adding commercial connections rapidly, the recent record being 100 per day.

INVESTMENT, RATES, ETC.—Throughout all the construction related to this investment by the city a high standard of design has been aimed at and a high grade of material and workmanship has been consistently demanded of all contractors. The city is fortunate in being able to borrow money at 4%, and it has therefore been desirable to make all structures durable and such that annual maintenance charges shall be small, even at the expense of investment charges. A careful calculation of the probable annual depreciation charges, with a sinking fund earning only 4%, show as a result of this policy the low rate of 1.3% on the capital investment.

In July last, a schedule of rates to be charged by the municipal plant was prepared, the same being 25% under the rates charged by the private company, which rates had been set at 10c. per kw.-hr with a 10% discount at the time of initiation of service of their own hydro-electric plant in 1906. Since that date, the municipal authorities have taken a step which is perhaps hard for an engineer to consider warranted—that of reducing the rate for residential lighting to the very low figure of 3c. per kw.-hr. This rate was instituted in December, 1911, and was immediately met by the private company. The chief argument which prevailed in the making of this decision was that of endeavoring to compel the citizens to become customers and supporters of the municipal institution, the City Council assuming that earnings on similar low rates would make the plant self supporting when the present equipment should be loaded to full capacity.

The principal contracts were in the

hands of Canadian or British firms; the generating station and transmission line was built by local parties; the turbines were secured through a London house, though made by the firm of Verkstaden, Kristenhamn, Sweden; the generators were built by Vickers, Sons and Maxim (now Vickers Ltd.) of Sheffield, England; all transformers and switching apparatus were provided by the Canadian Westinghouse Co., Hamilton, Ontario.

The first engineering report was made in 1906 by Messrs. C. B. Smith, of Toronto; Wm. Kennedy, Jr., of Montreal, and Col. H. N. Ruttan, of Winnipeg. Their estimate for the construction of the works comprising generating stations, the transmission line, and the terminal station was almost exactly met in the construction, the excess not being more than 7%. The design and construction were placed in the hands of C. B. Smith, and later were handled by his firm, Smith, Kerry & Chace, of Toronto, the writer being its representative resident in Winnipeg. Col. H. N. Ruttan, Dr. Louis A. Herdt and William Kennedy, Jr., formed a consulting board, advisory to the City Board of Control and the Council. John G. Glassco, who was for the past year and a half assistant to the writer as electrical engineer, is now general manager.

Design for the New Capital City of Australia

The Australian government in 1911 issued an invitation for competitive designs for the new capital city to be erected on the site selected in the Canberra district, New South Wales. The first prize has been awarded to the design of Walter Burley Griffin, architect and landscape architect, of Chicago, Ill., and we present herewith a general plan of this design, together with a description prepared from information furnished by Mr. Griffin and taken in part from the statement which accompanied his plans. The conditions leading to the construction of this new city were explained at some length in our issue of Sept. 28, 1911, but may be briefly reviewed in relation to the plan now adopted.

The present Commonwealth of Australia was formed in 1900 by a federation of the several Australian colonies, and the constitution provided for the establishment of a capital city to be located in a federal district owned by the general government so as to be independent of the individual states. This arrangement is based upon that of our capital city of Washington, located in the District of Columbia. The territory selected is in the Canberra District of New South Wales, and has an area of about 900 sq.miles. The site prescribed for the city (five miles square, exclusive of suburbs) is in the northern part of this district, about 170 miles southwest from Sydney, 300 miles northeast from Melbourne and 170 miles from the east coast. Its average elevation is 2000 ft. above sea-level, but it includes mountain ranges with peaks rising to a height of over 6000 ft. Across the site flows the Molonglo River, a sluggish stream 300 ft. wide, but subject to floods.

The geological survey of the site shows a variety of rocks (limestone, quartzite, sandstone, etc.), but none very suitable for building purposes, though good granite can be obtained at quarries about 18 miles distant. The water supply will be obtained by gravity from the Cotter River, which is satisfactory both as to quality and purity, and is a mountain stream having a mean flow of over 50,000,000 gal. daily. Its drainage area is about 28x5½ miles, and the run-off is from 24 to 34% of the rainfall; this high percentage is due to the steep slopes, the impervious character of the rock formation, and the limited evaporation in the river's narrow and sheltered ravine. The average rainfall at stations near the city site, ranges from 17.25 to 53.65 in. A comparison of rainfall and temperature conditions with those of other important cities is given in the accompanying table, which is condensed from a report by H. A. Hunt, Commonwealth Meteorologist. The sewerage system has not been worked out, but involves separation of sewage from the storm-water because of the extreme variation in the freshet run-off, for which an open-channel system to the Molonglo basins has been indicated. For the filtration of sewage there are available in the Molonglo basin alluvial and sandy tracts which may be used for irrigation and fertilization, and it is suggested that several different areas could serve respective sections of the city.

The site selected for the city is wild and open country, with no settlements and no railway communication, so that in planning the city the designers had a free hand and no artificial or conventional limitations. It may be noted that no name has been selected for this new city.

The Prize Design

From the above outline of the general scheme and the characteristics of the site selected, we turn to a consideration of the design which has been awarded the first prize. The plan given herewith shows the main contours, and some further idea of the topography may be gathered from the description. The natural characteristics which are utilized in this design include the following:

1. Sheltering forested ranges and distant snow-capped peaks at the south and west form the background, setting off the conspicuous group of government buildings as seen from the main part of the city proper. Two of these peaks, Bimberi and Coree, rise to heights of 6230 and 5290 ft., respectively, the former having its summit covered perpetually with snow.

2. Three local mountains with elevations of about 2750 ft. (Ainslie, Black and Mugga Mugga) would be reserved as natural parks, and these are utilized for aspect and prospect. They are treated as the terminals of the principal axes of the plan and of many important vistas, while they are developed also as attractive view points overlooking the city. They would afford sites for commemorative or monumental structures.

3. Several lesser hills are utilized as the terminals of radial thoroughfares and as sites for important structures. Those in the city proper, for instance, form sites for such centers and structures as the capitol, the parliament house, the city hall, the railway station, the market and the principal church; while another, to one side of the city proper, is utilized as a site for the citadel or military post. In the outlying and residence districts, hills are in general avoided by a geometrical arrangement of streets and avenues adapted to the topography, and certain summits would form sites for large residences, hotels, sanatoria, etc.

4. The sheltered and flatter areas of the valleys, which comprise the greater proportion of the city, are utilized for the general purpose of industry and residence.

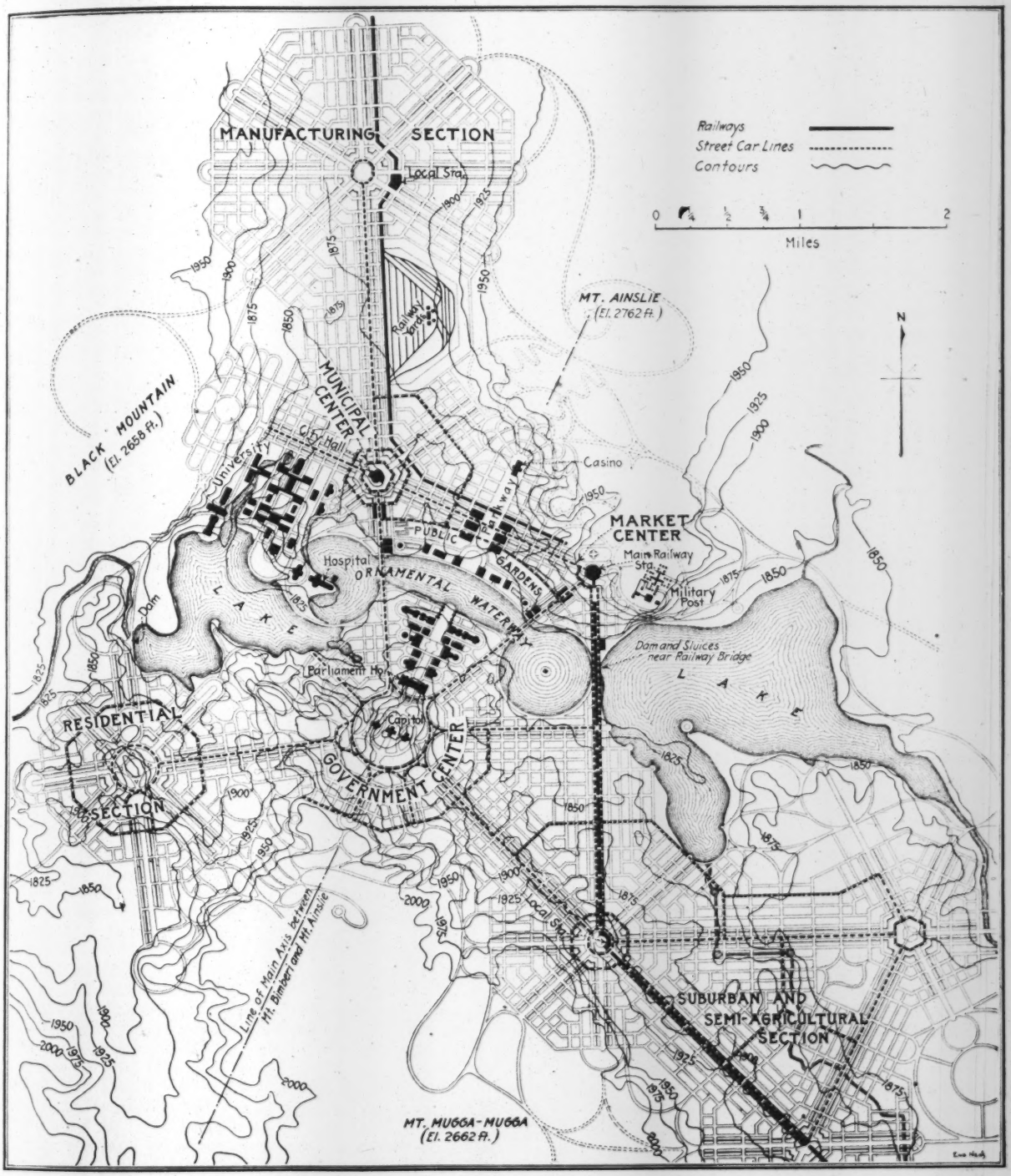
5. The river has been utilized to develop an important water feature of the plan, for decorative effect, recreation and climatic amelioration. This feature is described more fully below.

General Plan

The first primary feature of the design is that the government buildings are grouped on the south side of the river, which at this point is developed as an ornamental waterway not only forming an attractive feature in itself, but serving

TABLE OF CLIMATIC CONDITIONS OF VARIOUS CITIES

City	Height above sea level, ft.	Average annual rainfall in.	Temperature, Deg. F. Maximum	Minimum	Average hottest month	Average coldest month
Capital of Australia	2000	22.63	104.0	11.1	68.4	39.7
Sydney	146	47.97	108.5	35.9	71.6	52.2
Melbourne	91	25.42	111.2	27.0	67.4	48.5
London	18	23.13	89.4	10.8	....	....
Berlin	115	22.88	98.6	—13	66.0	30.0
Buenos Ayres	72	36.82	103.1	25.9	74.2	50.5
Calcutta	18	63.30	108.2	44.2	85.7	65.2
Cape Town	40	25.50	102.0	34.0	68.8	53.9
Johannesburg	57.50	31.63	94.0	23.3	68.12	48.9
Chicago	583	33.54	104.0	—23	72.3	24.0
San Francisco	189	22.77	100.0	29.0	61.0	50.0
Washington	75	43.80	.....	.....	76.8	32.9



ACCEPTED DESIGN FOR THE NEW CAPITAL CITY OF AUSTRALIA

[Designed by Walter B. Griffin]

to separate the government section from the city proper and isolate it from the commercial centers and activities. This arrangement adds to the dignity and individuality of the aspect of the city as a whole. The next feature is the selection of several points for specific centers (civic, market, railway, manufacturing, residential, etc.). These points are developed as open spaces connected by broad avenues, while other avenues radiate from each center. These radial or longitudinal streets are connected by a system of cross or ring streets on a polygonal design.

The grouping of all public buildings is made with reference to two main axes; one is a land axis upon which the federal or governmental buildings are located, and which lies between the summits of Mt. Ainslie and Mt. Bimberi, a distance of 30 miles. The other extends across the one first mentioned from the river to Black Mountain, and will be made a dis-

tinctive water axis by the development of the proposed waterway. These axes (and consequently all the government buildings) are located at a slight angle from the north-south and east-west lines, to secure advantages of light and shade. With streets conforming to the cardinal points of the compass 25% would be without sunlight, and on the diagonal streets there would be no shade during part of the day. These two coördinate axes are not primarily thoroughfares, but form the garden frontages for all the important federal buildings. Under a single source of control, unhampered by utilitarian considerations, they can be developed systematically and consistently as in the case of the Mall at Washington.

The Federal Buildings

The government buildings are grouped in a quiet area or reservation apart from the city and away from the business thoroughfares, but sufficiently easy of access. The capitol is the center of one of the polygonal street plans mentioned, and is the focus of nine avenues, but many of these lead only to the rocky hillsides of the highest residential areas and none of them approach nearer to the actual center than the limits of a hilly park. Two of the avenues, however, are thoroughfares to the two distinctive centers of the city, and both of these are provided with street railways.

The federal governmental buildings are in three groups or classifications: 1, the capitol, flanked by the governor's residence and the premier's residence; 2, the parliament house (or houses); 3, the departmental buildings. The first is on an elevation about 160 ft. above the river level and the second is on an elevation 70 ft. lower, but 40 ft. above the lower terrace of the third group, which is next to the water basin, this group occupying the slope down to the water front. All the buildings are arranged about the main axis, with Mt. Ainslie as the terminal point of view. All of these buildings look down upon the waterway and public gardens, beyond which a broad parkway, lined with trees and fine residences, continues along the line of the axis, terminating at a casino on the slope of the mountain. This terminal point is at such an elevation as to afford a view over the city, while beyond are developed paths and roads in a wooded park extending up the slope. The width of this parkway would be 600 ft. and the distance between the Parliament House and the casino (forming the view points) would be about two miles. At the water front the parkway ends in public gardens facing the governmental center across the river.

The City

The city proper forms a unit in itself, independent of but in close relation to the federal unit. The main municipal group ranks next in importance to the federal group, and for this (unlike the latter) accessibility is a prime consideration. The municipal section is grouped upon two centers, which are points on main axial thoroughfares radiating from the government center and crossing the formal waterway by handsome arch bridges at the narrower channels connecting the central and end basins. These three centers and their connecting avenues form an equilateral triangle (with sides approximately 1½ miles long), having the federal group within the apex. Each of the two municipal centers is designed as a large open space, capable of park treatment and surrounded by buildings of suitable style and character between the radiating streets. The centers of this municipal section are at a sufficient distance apart to prevent congestion and to allow for future expansion, while maintaining the feature of ready access from the railway, the capitol, the minor centers and the residential areas. The first group (or municipal center) comprises the city hall, post office, criminal and city courts; and also the banks, exchanges, and office buildings. The second group (or market center) comprises the central railway station and the markets, around which will naturally assemble wholesale and retail merchandising, and possibly light manufactures. Midway between these centers, and at the intersection of their connecting avenue with the parkway already described, is a secondary center which may be classed as the recreation center. Here are grouped the art galleries, museums, opera house and theater. Adjacent to these are the public gardens on the north bank of the waterway.

North of the city, in the outlying district flanking Mt. Ainslie, is a manufacturing and industrial district. Here provision is made also for railway freight yards, the gas works, and other unsightly or unpleasant but necessary facilities. It is suggested that a high-pressure gas system should be used, both for economy and the avoidance of large and unsightly gas tanks. To the southeast, and flanking Mt. Mugga Mugga, provision is made for the developing of an agricultural suburb or village district suitable for truck and poultry farms, greenhouses, nurseries, etc. Two subsidiary but important provisions of the general plan are the university and the military post. The former is located at the western side of the city, adjacent to the waterway and with grounds extending up the slopes of Black Mountain. The latter occupies a commanding position on an elevation adjacent to the eastern side of the city. It may be noted also that the peninsula in the western circular lake is utilized as a semi-isolated location for the general hospital.

Private buildings are distributed between the main architectural axes, along as many lines as possible connecting the public groups. The arrangement is such as to provide rectangular building sites or blocks as far as the junctions of adjacent polygonal systems; but even at these points sites with acute angles are avoided, as triangular buildings are both expensive and ugly. Instead, the obtuse angles afford a quadrilateral disposition, as economical as the rectangular, with two long prospects at each sweep of the connecting ring streets.

The parallel streets decrease in length, in accessibility and in importance in direct ratio with their distance from their main axis. This arrangement furnishes sites approaching more and more to the ultimate of inclosed courts best adapted for the seclusion and quiet of residence use and unfavorable to the intrusion of business. In these districts the unit block size may be varied to provide for public gardens, playgrounds, residential hotels or subdivisions, sanatoria, educational institutions, etc., with minimum interference with the main traffic of the city. At the same time, the diagonal traffic lines and business boundaries of these districts bring them within ready reach of rapid-transit lines, the maximum distance from a street railway being four or five blocks. The blocks are 800 to 1000 ft. long, and the reduction in proportion of street area to private ground resulting from this rather unusual length adds materially to the space available for use and economizes in the cost and maintenance of paving, piping, sewers, etc. Mr. Griffin notes the advantages experienced in this direction in a suburban town where the alternate streets of the original plan were omitted, thus leaving blocks 1200 ft. long. In the residential sections of irregular topography, the streets follow mainly the depressions and ravines, thus giving the advantage of elevated building sites and sheltered streets, while at the same time economizing in the cost of grading, pipe service, drainage, etc. The width of residence streets is in general 100 ft.

General business locations are provided both in the neighborhood of the various sections and along the radial and short-cut lines of traffic. The blocks on the long avenues are narrowed by reason of the increased width of these avenues (200 ft., or double that of the others) and the provision of a 25-ft. rear alley or shipping way. All cross streets should be carried at least one block to either side of the avenue, even in outlying places where alternate streets may be omitted beyond this one block length. This improves accessibility, and provides what are in effect recessed courts susceptible of special architectural treatment. As far as the long lines of main streets are concerned, experience shows that trade and business will develop along such streets. The 200 ft. width for avenues is advocated for the reason that three lines of traffic must be provided

(including a street railway and a roadway for fast vehicles in both directions). Such traffic in unbroken lines would make the streets dangerous and unpleasant as well as unsightly; consequently intermediate parkways must be provided with lines of trees and shrubbery.

In the laying out of the valley areas for residence and industrial purposes the main considerations were as follows: 1, suitable plot units, the ideal being rectangles of varied size; 2, facility of access; 3, special accommodations for groups or centers in future extensions for manufacture, agriculture, etc., and to adapt the varying degrees of access and frontage to accord with their uses and functions.

Transportation

In regard to the arrangement of the streets, the design recognized the fact that under modern conditions of city life and methods of transportation, the travel between points of any material distance is by car rather than by foot. Consequently convenient access to car lines and a systematic arrangement of routes of transportation is of more importance than straight streets between such points. By this feature, the range of distribution and suburban development is much greater and suburban centers are provided on the plan at points topographically most suitable. This is done in order to give some idea of the general extension of the principle of special centers, radial axes and rectangular building sites. It is suggested in this connection that it is advisable to determine the lines of extension as far ahead as possible (as has been done in some German cities) in order to prevent an ultimate obstruction of orderly growth through land speculation or misdirected improvements.

There is no railway at present, but one is to be built, and consequently designers had practically a free hand in arranging the railway facilities of the new city. Mr. Griffin locates the route as indicated on the plan. Coming in from the north it passes through a district provided with industries, warehouses and ample freight-yard accommodation in the outskirts. It then continues on depressed tracks following the street lines to the Central Station, where the tracks and platforms are below ground and the building itself is in a slight elevation, thus forming a conspicuous point for a handsome structure. The cut would be about 12 ft. deep, with the excavated material placed on either side to a depth of 6 ft. This reduces the depth of cut and at the same time gives sufficiently easy grades for the approaches to the street bridges. South of the station, the line comes out into the open, crosses the waterway at the upper end of the first circular lake and continues as a depressed way between two wide avenues, each of which has a street-railway track. Local stations would be provided at intervals for the convenience of urban and suburban service.

Public Buildings

The prime object of the city is for governmental and not commercial purposes, and involves the accommodation of deliberative and educative activities which demand an air of quiet and retirement. The arrangement and treatment of the public buildings, therefore, are governed by architectural rather than traffic considerations, and demand homogeneous treatment which must dominate all other constructions. As to the design, Mr. Griffin takes the important stand that no historical or conventional type or school of architecture should be followed, but that a style should be developed to meet the conditions of use, and climate and modern requirements, instead of simply adopting a Greek, Gothic or other style under conditions with which it is not compatible. He suggests that perhaps the fullest scope for individuality and dignity has been given to designers in the great exhibition projects. Typical and best of these is considered the Columbian Exhibition, at Chicago (1893), with its ever memorable "Court of Honor," where the restriction to one colossal scale and single type of design around a rigidly formal inclosed court produced an impression outlasting those of all subsequent designs.

The element of haste which is necessary in the design of an exhibition project, and which may afford a plausible excuse for the adoption of an historical motive, would not apply in the case of a capital city, the full development of which would extend over a long period of time. In place of the "inevitable capitol dome," he shows a stepped pyramid treatment, which has been a feature of the architecture of many early and long-lived civilizations.

Largeness of the unit buildings is an important requirement, which with modern fireproof construction provides the cheapest, the most convenient and the most monumental structure for the required purpose. With liberality in public space, judicious distribution of centers, and facility of communication between all points, the city can avoid the necessity of putting this feature of largeness into height alone, as in the congested centers of American cities. A horizontal distribution of the large masses secures better air and sunlight, greater beauty, and better facility for treatment with surroundings of grass, trees and shrubbery.

For the main material of construction reinforced concrete is proposed by Mr. Griffin, who remarks that this is the "newest, cheapest, most durable, least limited, most plastic and variable single medium yet introduced into construction." Any desired tint or character of exterior finish could be embodied in the concrete itself by the use of suitable aggregate in the facing portion of the concrete, an acid wash being used if necessary to eliminate the flatness of a cement surface and so produce a granular or roughened surface. Decorative features could be molded and cast separately. These methods have been used successfully, but the bold suggestion of their application on such an extensive scale as the public buildings of a great capital city indicates a recognition of the great possibilities of concrete in architecture as well as in engineering.

Waterway Development

The river Molonglo traverses the site of the proposed city, and is utilized for developing an extensive water center which is not only distinctive in itself but is specially appropriate for a country which has such a relatively hot and dry climate as Australia. Directly in front of the government buildings, and separating this group from the city proper, are three formal basins, separated by the bridges on the two main avenues between the Capitol and the city. The water level will be maintained by a dam near the western limits of the city, and a secondary dam with weir and sluices (and lock) is proposed near the railway crossing, so that the reach above this (now subject to flood) may form a lake amid natural surroundings. The central basin would be utilized for racing (there being a one-mile course between the bridges) and for aquatic sports, and on the north bank will be a stadium forming the terminal of the parkway already mentioned. Opposite the stadium and at the foot of the group of government buildings a water gate or pavilion of elaborate design is provided. The north bank of the central basin, extending between the bridges and up to the main avenue connecting the two municipal centers, is arranged as a public garden and park.

The Designer

Walter B. Griffin, whose design (described above) received the award of the first prize in the competition, is a Chicago architect whose work has been principally in connection with buildings of a residential character. In this work he has exemplified his ideas as to developing a design suitable to the conditions rather than to adapting conventional types to structures and conditions with which they are not in accord. In addition he has carried out several relatively small schemes of landscape architecture and town planning, including the planning of the new town of Idalia, Fla., for a prospective population of 2000, and work on this is expected to be commenced this year. He also prepared a design for a new city at Shanghai, China, a few years ago, when it was proposed to establish a modern city on a new site, and to abandon the old city, which is largely an insanitary collection of native huts. The delegate from the Chinese

government to the St. Louis Exhibition had plans prepared by Mr. Griffin, but owing to the death of the delegate on his return to China nothing was done toward carrying them out. Mr. Griffin was born at Maywood, Ill., in 1876. He is a graduate of the University of Illinois and a member of the Illinois Chapter of the American Institute of Architects.

Methods and Costs of a Water Leakage Survey at Lancaster, Penn.*

By F. H. Shaw†

The City of Lancaster has a population of about 50,000. It has an area of four square miles, about three of which are built up, the houses being constructed of brick with practically solid fronts between streets. This method of construction gives a population of about 25 per acre.

The city is supplied with water by a municipal plant which pumps water from Conestoga Creek. The water is filtered and pumped into the city against a head of 250 ft. The supply is measured by a Venturi meter located between the filter plant and the pumping station. The distribution system consists of 70 miles of pipe varying in size from 24 in. to 4 in. There are about 10,500 services in use, one-third of which are metered. All large consumers are metered and meters are being installed at the rate of about 400 per year, all new properties being metered.

The per capita daily consumption averages about 140 gal. This excessive consumption led to an investigation of causes and methods for correcting same. A general house-to-house inspection was made during the winter of 1910, at which time all plumbing was inspected for leakage. Results of this inspection were recorded on a card for each property inspected. As a result of this inspection the yearly income from water rents was increased $3500. The city was then divided into four districts, and a regular inspector appointed for each district. A yearly inspection is made of each house and property owners are compelled to repair all leaky fixtures within 10 days, 480 causes being reported and repaired during the last year.

During these investigations the necessity of a systematic search for leakage from mains became apparent and the discovery by accident of a leak which was costing the city about $10,000 per year, brought the matter to a head and the necessary appropriation was made.

The survey party was organized from employees of the water department, a foreman who had been in the department for 20 years being placed in charge of the work. The party worked 9 hours per day and was composed as follows.

ORGANIZATION

Foreman, per day	$ 3.00
Single team and working driver, per day	2.50
Three laborers at $1.80 per day	5.40
Total cost per day	$10.90

OUTFIT

One 4-in. meter with 2½-in. connections on truck
One ¾-in. meter
One pressure gage
Two 25-ft. lengths 2½-in. fire hose
250 ft. 2½-in. galvanized pipe
One small tool box
Picks, shovels, wrenches, caulking tools, lead, wool, etc.

The first step in preparing this work was an inspection of all valves and repairs to same, placing them in working order and replacing some which could not be operated. This work was done by the men in the distribution department in advance of the survey. The survey was started Mar. 6, 1911, and stopped for the winter on Dec. 13. The method of procedure was as follows:

The 4-in. meter was mounted on a small four-wheeled truck and the connections bushed down to 2½ in. with a 2½-in. valve at the inlet and outlet. The large meter was bypassed by a ⅝-in. meter for use on small flows. A pressure gage was attached to the outlet end of the large meter. The districts tested had an average area of 12 acres, containing about 80 houses. The district to be tested was shut off from the remainder of the system by closing all valves on street mains. The meter was then connected with a hydrant outside the district by means of a 25-ft. length of fire hose. The 2½-in. pipe line was laid from the meter to a hydrant inside the district, being connected with it by another short length of hose.

The consumption of the district was then measured for one hour, readings being taken every 10 minutes and any reductions in pressure noted. Any considerable drop in pressure indicates either a large leak or that the district is too large to be supplied through 2½-in. pipe. After the consumption had been measured, all connections were shut off inside the houses, an inspection of house plumbing being made at the same time. A test was then made to determine whether any street valves were leaking water into the district by opening a fire hydrant and watching for any flow from the opening.

After everything was shut off the leakage was measured by the large or small water meter, according to the amount. This flow, if any, represented the leakage from mains and also from the service. To locate the leaks, the streets inside the districts were cut out one at a time by closing the valves until the leak had been located between two valves, after which it was located by using the telephone on curb steps, hydrants and on drills driven down to the main. After the leak had been definitely located, it was dug up and repaired by the survey party and the district tested until found tight.

The work was carried on for 240 days at a cost of about $11 per day, or $2640 for the season of labor. The cost of lead, wool, etc., for repairing leaks was very small. In all, 111 districts were tested, having a total area of 1310 acres, or 12 acres per district. There were approximately 9000 houses in the territory covered. Following are the leaks discovered and repaired:

RESIDENCES

Closets		20	
Yard hydrants		10	
Faucets		19	
Service mains		17	
			66
Street valves	12		
Fire hydrants	35		
Street mains	29		76
Total			142 leaks

The leaks varied from 1 to 19 cu.ft. per minute. The largest leak found was a 3-in. elbow split wide open and running at the rate of 205,200 gal. per day. This line had been bypassed around the meter outside the building and was supplying four buildings. In this case the survey not only stopped the leak but detected the illegal use of water. This leak amounted to 75,000,000 gal. per year, the actual cost of furnishing which was $2812, or $172 more than the cost of the entire survey.

The total mileage of mains inspected was 40.8, varying in size from 4 to 24 in. The total leakage record was 118 cu.ft. per minute, or 1,271,000 gal. per day. Using $37.50 per million as the actual cost of furnishing water, exclusive of interest, the total leakage was costing the city about $17,000 per year.

About one-quarter of the system remains to be tested, also the 20-in. supply main which runs directly across the city. Work is now in progress on this section.

One mile of 36-in. force main was laid in 1888, and tested by closing the valves at both ends, and supplying it from the other force main through a small meter. Leakage was found amounting to $2000 per year. The joints on this main will be dug up and re-calked during the present season. The results of the leakage survey were not as apparent as was expected, for two reasons—one of which was the exceedingly dry summer and the failure to provide for street sprinkling by wagons, causing a great increase in the use of individual hose sprinklers. Another reason was the exceedingly cold weather during the winter, which caused an excessive use of water to prevent freezing and also damaged many service mains, all of which have probably not been discovered. After the present survey has been completed, some of the districts will be retested to ascertain the damage caused during the past winter.

As an investment I believe a survey of this kind, which not only locates but repairs leaks, is a good one and well worth following up until assured that the distribution system is reasonably tight.

*Condensed from a paper read before the American Water Works Association, June, 1912.

†Consulting Engineer and Superintendent Water Department, Lancaster, Penn.

Expert Opinions on the Loss of the "Titanic"

The British Court of Inquiry which is investigating the loss of the "Titanic" has recently had before it a number of technical witnesses whose testimony is of much interest in view of the many engineering questions raised at the time of the great disaster. The testimony of these witnesses is reviewed in *Engineering* of June 14, from which we abstract the following particulars of special interest:

The first witness examined was Edward Wilding, naval architect to Harland & Wolff, the firm which built the vessel. Upon the question to what depth the colliding ice penetrated into the ship's hull, Mr. Wilding stated that there was a water-tight tunnel or fireman's passage extending from boiler room No. 6, the forward boiler room, forward to bulkhead No. 2, where it terminated in a water-tight trunk, up which spiral staircases extended to the lower deck. The corner of the casing of this water-tight passage came at one point within 3 ft. 3 in. of the skin of the ship. As water gained access to this passage, it is evident that at some point at least the ice must have penetrated the vessel far enough to crush or penetrate this trunk. Mr. Wilding believed that the injury to the skin of the vessel took place in a series of rents, there being a number of punctures through the hull and not a continuous opening. From all the available evidence, Mr. Wilding had computed that the weight of water entering the ship within 40 minutes after the accident was some 16,000 tons. This entered with a head at the start of about 25 ft., which would be reduced as the compartments filled. From these data he had computed that the total area open for the inflow of water was about 12 sq.ft. Since the damage to the hull extended for a distance of 200 ft. along the side, this would give an average width of opening of only ¾ in. He concluded, therefore, that the damage was probably a series of independent punctures.

Boiler room No. 5 was the aftermost part of the ship where there was evidence of direct damage to the hull, but the water was also said to have risen in No. 4 boiler room, coming up through the floor. In his opinion, however, the water in this compartment did not come direct from the side of the ship.

Regarding the claim that the hull broke in two before sinking, this was certainly wrong. Even with the stern out of the water before the final plunge, calculations he had made showed that the stresses on the plating were not greater than would have been experienced in such an Atlantic storm as the ship was designed to resist.

Concerning the statement that the boilers exploded as the ship sank, Mr. Wilding did not believe there was any such explosion. The boilers, however, would probably slip off their supports when the ship was 35° down by the head. The fall of the funnels came about because as the ship went under water the water rose faster outside the casing which supported the funnels than inside. This casing was not designed to stand heavy external pressure and thus collapsed letting the funnel fall.

It had been suggested that if a deck a little below the water line were made water-tight it would have prevented the rise of the water in the pierced compartments; but there were arguments against this. While in the present case such a water-tight deck might have saved the vessel, in case the vessel was pierced above the level of this deck, the water which came on board on top of the deck might produce a capsize. Another objection was the difficulty of making such a deck really water-tight in view of the necessary openings for cargo hatches, ventilation of the boiler rooms, etc. Such a construction moreover would make considerable portions of the ship valueless for either passengers or crew and Mr. Wilding agreed with Lord Mersey's suggestion that once a ship ceased to be commercially workable she ceased to be seagoing.

With reference to the question whether the ship's boats could safely be lowered when carrying their full complement of passengers, Mr. Wilding said that one of the "Olympic" boats was actually raised from the water to the boat-deck level on May 9, 1911, when carrying a load equal to the full complement of passengers. The weight in that case was equivalent to 65 people on board. With this weight the boat was lowered six times, and was afterward found to be quite unstrained.

Mr. Wilding thought that if the "Titanic" had struck the iceberg head on she would have got to port all right with her passengers, although some 80 to 100 ft. of her bow would have been crushed in. He recalled the "Arizona's" collision with an iceberg 34 years ago. That vessel was saved with bad damage to the bow.

As to the possible advantages of longitudinal bulkheads, he said that the Bulkhead Committee of 1891 had rather discouraged their adoption on account of the possible listing of the vessel due to the filling of compartments on one side.

Concerning the use of searchlights on ocean steamers, he said that such lights were useful in a narrow channel such as the Suez Canal, but were inadvisable when the lookout had to cover a considerable arc, as objects not in the direct line of the searchlight beam were more difficult to distinguish. A searchlight was at one time fitted to the "City of Paris" and abandoned because it was found useless. While a searchlight might show an iceberg, he doubted whether it would discover a derelict lying low in the water.

As to the question whether greater safety to passengers was to be secured by increase floatability of the hull or increased boat accommodation, he held a very strong view in favor of the former alternative.

L. Peskett, naval architect to the Cunard Company, gave as his opinion that for very large vessels a system of combined transverse and longitudinal bulkheads was the best. This system is used on the "Mauretania" and "Lusitania," for the design of which he was responsible. The longitudinal bulkheads are not in the center of the vessel but at the sides. There are on the "Mauretania" 69 water-tight doors in the bulkheads. The height of the bulkheads in these two vessels varies from 22 to 23 ft. above the water line at the ends of the vessel to 17 ft. amidships. These are the only two boats so far which are subdivided in this way. Mr. Peskett strongly believes also in fitting a water-tight deck below the water line. In the "Aquitania," now building, he has made the water-tight deck continuous, the engine and boiler hatchways being carried up through it as cofferdams as far as the top deck. The same system of subdivision is now being adopted for the new German liners. For ordinary ships, however, he considered transverse bulkheads sufficient.

Capt. C. A. Bartlett, marine superintendent of the White Star Company at Liverpool, testified that in his opinion any considerable increase in the number of lifeboats carried would be unwise. He was also strongly opposed to the use of searchlights on vessels or to providing the look-out men with binoculars. Capt. Bertram Hayes, commander of a White Star vessel running on the Canadian route, said that on this route ice was frequently met with, particularly off Belle Isle Strait. He never slackened speed in clear weather because of the presence of icebergs, nor did any other Atlantic liner. Icebergs in clear weather could be seen 5 to 6 miles off, and he had seen them at 10 miles. He had run at full speed between bergs on a dark clear night without hesitation. He had never seen a black berg such as was said to have caused the disaster to the "Titanic," and the conditions must have been abnormal to an extraordinary degree. Captain Hayes' evidence was confirmed in every particular by Captain Passow, of the American Line.

Captain Miller, assistant hydrographer to the Admiralty, stated that on the whole he thought the disadvantages attaching to the use of searchlights in merchant ships on the transatlantic passage outweighed the advantages. If they were adopted, the most stringent regulations should govern their use.

The Pittsburgh Hump Regrade

We show herewith three views of the Pittsburgh regrading work, which was outlined as to plans in our issue of Jan. 11, 1912, p. 52. This work, covering the most active and densely traveled streets of the city, presented unusual difficulties. The city authorities specified, therefore, that it was to be done in two sections, one to be carried on during 1912 and the other to be taken up when the first section was substantially completed. The first section (refer to map, ENGINEERING NEWS, Jan. 11, page 52) embraces Fifth Ave., Oliver Ave., Webster Ave., Cherry Way from Sixth Ave. to Fifth Ave., and the lower end of Wylie Ave., together with a few side streets. The second part includes Sixth Ave. and the immediately adjacent portions of Grant St. and Diamond St. with its connection to Forbes St. In this way the important street-car route, Fifth Ave., is to be completed before the Sixth Ave. and Diamond St. routes are interrupted.

Work has been actively in progress on Fifth Ave., and at the present time this street from Smithfield St. to Grant St., and that portion of Grant St. extending from Webster Ave. to a little south of Fifth Ave., are nearly down to their final level and can soon be restored to a traffic-carrying condition.

FIG. 1. LOOKING DOWN FIFTH AVE. FROM GRANT TO SMITHFIELD STREETS

FIG. 2. CORNER OF GRANT ST. AND FIFTH AVE., LOOKING EAST

Fig. 1 herewith gives a view down Fifth Ave. from Grant to Smithfield Sts. The Frick Bldg. is immediately at the left and the Carnegie Bldg. just beyond. The cut at the intersection of Fifth and Grant is 14.2 to 14.9 ft., and the resulting grade on Fifth Ave. will be about 4.87%. The work is mainly in rock; a steam shovel has been employed for the heaviest part of the work. The street-car lines which traverse Fifth Ave. have been diverted to Diamond St. under a special franchise granted by the Council, to be shifted back when Fifth Ave. is in shape to receive traffic again, and then permit the grading of Diamond St. Fig. 2, a view on Grant St. at Fifth Ave., looking east, gives an even better impression of the complete interruption of street use by the regrade work.

FIG. 3. FIFTH AVE. AND ROSS ST., BEFORE BEGINNING WORK;
(Cross marks original surface before a cut made 40 years ago.)

An interesting reminder is given by Fig. 3, showing the existing grade at Fifth Ave. and Ross St. This point has been previously graded down, a cut of so ·e 12 ft. having been made about 40 years ago. The cross marked on the photograph indicates the former ground level, and an alley-way which existed in the building before that change can be seen in the view bricked up, with a new alley entrance cut in the former cellar wall below. The store in the view occupies the former cellar of the building. The present regrade requires a cut of from 6 to 8 ft. at this point.

Painting the Steelwork of Engine and Fireroom Bilges*

BY HENRY WILLIAMS†

When steel ships and, for that matter, steel buildings came first into general use, it was anticipated that especial precautions would have to be taken to protect the steel from corrosion. In the case of ships it was concluded naturally that the outer-skin plating, the part most exposed to the corrosive action of the water, would be the first to deteriorate. As the integrity of the structure depends upon keeping the hull intact, a great amount of care and attention always have been bestowed on that part of the ship.

There is another motive in caring for the outer hull of a vessel, and that is the necessity for keeping its surface clear of marine growths and other fouling matter. These two considerations combined have resulted generally in such good care that one practically never hears of a steel ship that has had a hole in its bottom plating due to corrosion from the outside.

Frequently holes come as a result of corrosion on the inside. More frequently, perhaps, because nearly all sea-going vessels nowadays have double bottoms, it is the inner bottoms that suffer most from the corrosion, and the locations affected are almost invariably in the machinery spaces. It is a well known fact that the steel structure in these spaces is especially liable to corrosion and that it is most difficult to keep the surface properly covered with paint. Some ship builders even have adopted the expedient of using wrought-iron plates for inner bottoms in this space, with the idea that it is less subject to corrosion than steel.

Under the electrolytic theory of corrosion, which now is accepted generally, all corrosion of steel surfaces is due to a

*From the "Journal of the American Society of Naval Engineers" for May.

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difference of electric potential between adjacent points. This may be caused by the uneven distribution of the various components or by the presence of a different metal. Where such difference of potential exists, a current will pass when there is an electrolyte present. Moisture is sufficient for this purpose.

The conditions requisite for liability to corrosion are present usually in the locality under discussion. There is almost continual presence of water in the bilges, and it may be hot and salty, or have in solution lye or the soluble salts from ashes, all of which make it more effective as an electrolyte. Further, it has mixed with it frequently ashes or oil, so that ordinary paint has not much chance of adhering, even if through an unusual effort the bilges are dried and cleaned sufficiently to permit of their being painted at all. The ashes exert an abrasive effect on the paint, and the oil and lye often soften and dissolve it. There is often a considerable acceleration of the electrolytic action due to the large amount of brass and copper used in piping and structures and the frequent presence in contact with the steel or brass and copper filings, or articles of brass stowed in the bilges. The heat of the boilers and of the steam pipes stimulates corrosion, and frequently there is local corrosion due to continued drip of water at some spots.

The serious deterioration has taken place on naval vessels, due to such corrosion in the past, is evidenced by the bills for repairs to the inner bottoms in machinery spaces. It is the universal experience that at the end of about four years' service it begins to become necessary to patch inner bottoms, and after about ten years the repairs are so extensive as to have cost in the case of a battleship overhauling recently for structural work alone about $15,000, besides the incidental costs. These repairs are especially difficult and expensive, due to the necessity for removing piping and auxiliary machinery and to the restricted spaces in which the work must be done.

The writer has had occasion recently to inspect the bottoms in machinery spaces of a number of older vessels in the Navy, and found in every case very marked deterioration of the inner bottom or, on ships having none, of the framing, floor plates and shell plating. This took place in spite of considerable effort of the ship's people to scale and paint the metal, and in several cases there was abundant evidence that the corrosion had proceeded under an apparently sound coat of red-lead paint.

Formerly the painting instructions for naval vessels required that all metal surfaces below the floor plates in engine and boiler rooms be given at least three coats of red-lead paint made with linseed oil. This method of painting was in vogue for many years, and to say that it has not proved satisfactory states the case mildly.

In the first place, due to the continual presence of moisture of condensation, if not of actual water in the bilges, it is extremely difficult to apply the linseed-oil paint so that it will adhere to the metal and afford the protection it is intended to give. In such cases frequently there is a film of paint apparently sound, but under which corrosion is taking place. In other cases the paint applied has not adhered and the metal was left bare until opportunity came for another trial.

Consideration of the characteristics of paint made from red lead mixed with linseed oil should condemn its use for such locations. Linseed oil is a gylceride of fatty acids and it may be saponified by the action of water alone. This saponification explains the well known fact that linseed-oil paints, especially those containing lead, which aids the action, do not resist water. There are, however, many paint pigments and vehicles that do not resist the action of water, and special damp-resisting or waterproof paints are made and sold by many firms. Asphaltum products usually are the bases of such paints, China-wood oil and linseed oil treated to eliminate the glycerin being added frequently. There are in existence many paints which, being waterproof, are better suited for the purpose under discussion than red lead and linseed oil. This quality of waterproofness alone does not meet the difficulty of rendering the surfaces dry for a sufficiently long time to permit the application and hardening of the paint. There are damp-proof paints which have the quality of drying in the presence of moisture, and for many locations on shipboard beside those in the machinery spaces such a paint would seem to be almost indispensable.

Of all protective coverings, portland cement probably is the one used most commonly, outside of the naval service, for the protection of inner bottoms and bilges. Where it can be made to adhere tightly to the steel, it affords excellent protection. It should be borne in mind that there are some kinds of cement which contain calcium sulphate in excess and produce corrosive action on steel, through the breaking down of the sulphate into sulphuric acid.

Unfortunately, however, there are two objections to the use of cement in such quantities as would be necessary here. The first of these precludes it for warships, as its weight is prohibitive when applied in sufficient thickness to form a solid body. The second is the difficulty of obtaining adherence to large flat surfaces, such as inner bottoms of men-of-war, and which are subject to some distortion, either on account of the heat of the boilers or the pressure from the feed tanks underneath when filled with water under head. In spite, however, of its weight, portland cement offers many advantages for use in pockets and spaces that may be difficult or impossible of access for painting. For such purposes, considerable quantities are used even on naval vessels.

As has been noted above, among the most efficient of the damp-proof paints are those containing asphaltum as a base, and this class of paints has given excellent service in fire- and engine-room bilges. The best known, probably, are the so called bitumastic compounds, which have been used for a number of years in the merchant service, with excellent results. The Bureau of Construction and Repair recognized these facts several years ago and provided in specifications for new ships that bitumastic materials or their equivalent be used on inner bottoms in machinery spaces and on bulkheads and foundations in machinery spaces to the height of the floor plates. The name "Bitumastic" is the proprietary name adopted by one of the firms manufacturing and applying the materials, and seems to have been adopted to describe all similar materials, of which there are a number, apparently differing little in composition or efficacy.

The materials come in three forms, and all of them consist essentially of mixtures of asphalt and coal-tar pitch, thinned when necessary with coal-tar naphtha. The "solution" goes on cold as a first coat and the flats of the bilges are covered then to a thickness of about one-half inch with the "cement," which has, in addition to coal-tar pitch and asphalt, some portland cement. This mixture must be applied hot. The vertical surfaces are covered about ⅛ in. thick with the enamel, which consists only of coal tar and asphalt, and also is applied hot.

Formulas for making these materials were developed at the New York Navy Yard, and the results obtained from their use apparently are satisfactory. These formulas are in general as follows:

The "solution" may be made by melting 100 lb. of coal-tar pitch and 50 lb. of Trinidad asphalt. When liquid the mixture is removed from the fire, cooled, and thinners added, consisting of 65 lb. of coal-tar naphtha and 15 lb. of mineral oil.

The "enamel" may be made by melting together 350 lb. of coal-tar pitch and 350 lb. of Trinidad asphalt and boiling for about three hours.

The "cement" may be made by melting together 150 lb. of coal-tar pitch and 120 lb. of Trinidad asphalt and boiling for about three hours, when 150 lb. of portland cement is added and stirred in.

In all of these care is required in the heating, the quality of the material being dependent mainly on the manner in which it is accomplished. The solution goes on cold as a primary coat in all cases. The surface to which it is to be applied must be scaled and cleaned thoroughly, and be free from dirt, grease or paint. As a final step it is wire-brushed and then

brushed with a painter's duster. The solution should not be applied in cold weather when there is any "frost" in the metal.

As the fumes are highly explosive the greatest care must be taken in regard to the use of naked lights in the compartment while the material is being applied. It is necessary, also, to provide artificial ventilation in such compartments to permit the men to work to advantage. The priming coat of the "solution" is allowed to stand about 48 hours, and while it is still "tacky" the enamel or cement is applied. The cement goes on flat surfaces of bilges, while the enamel goes on vertical surfaces of framing bulkheads, sides of bunkers, trimming tanks, etc. Both, at the time of application, are melted in pots, handled in buckets, and must be worked quickly before they cool. The cement is poured onto the flat surfaces and spread to the desired thickness, about ½ in. The enamel is applied with a brush having heavy bristles and a handle about 15 in. long. It goes on in a thickness of about $\frac{1}{16}$ to ⅛ in. On flat surfaces overhead, such as bunkers, trimming tanks, etc., it is very difficult to apply, and for that reason the solution only ordinarily is used on such surfaces.

It has been suggested on account of the softness of the bitumastic cement and its tendency to run on sloping surfaces, that a layer of portland cement about ½ in. thick on top of the bitumastic will serve a good purpose in protecting from damage and insulating from heat the softer material. Experience with such an arrangement has been had in the case of the "Ajax," of which the inner bottoms under boilers were coated in 1906, first with an asphaltic cement compound and over that with portland cement 2½ in. thick. This was inspected in 1911 and found to be in excellent condition, showing no sign of deterioration of any sort.

In order to test such an arrangement further, for purposes of comparison, the inner bottoms of the "Alabama" and "Tacoma," to which bitumastic compositions were applied in 1911, had one-half of their surfaces covered with portland cement about ¼ to ½ in. thick over the bitumastic.

In 1904, the writer inspected the bitumastic materials on the American Line "St. Louis," which had been applied during construction in 1894-95. Among other parts of the ship, the engine and fireroom bilges, foundations, boiler saddles, etc., were protected with the bitumastic. These spaces were in excellent condition and the protective coatings had received only minor attention since first applied. A naval vessel of the same age on which red-lead paint had been used in all probability would have had her inner-bottom plating corroded through and have required the expenditure of thousands of dollars in repairs, and during her service would have had much energy and many tons of red lead used upon it.

Experience similar to this was had with the sister ship "St. Paul," which was protected in the same manner with bitumastic compounds. When this ship went in 1906 to have boilers renewed at the Newport News shipyard, contract was made for the renewal of the bitumastic in the boiler spaces, as it was anticipated that the work of renewing the boilers would destroy it. Such did not prove to be the case, and the work of repair was confined to replacing the cement that had to be cut out to permit the structural work to proceed.

On the battleship "Arkansas," bitumastic was applied to the trimming tanks before launching, and, in order to trim the ship afterward, it was necessary to keep the forward ones full of water about eight months. At the end of that time the water was pumped out, the tanks washed down with a hose and the bitumastic was found to be in excellent condition, and required no further work. Had red lead been used, the metal undoubtedly would have had to be scaled and repainted throughout after such treatment.

It is readily conceivable that conditions might be such on a ship in commission as to prevent the application of the bitumastic, and in such cases recourse may be had to paint, and one of the damp-proof paints that have been proven in service should be given a trial. There are a number of these, though comparatively few appear to have been tried by actual use on naval vessels, due to the predilection for red lead. A damp-proof paint that is probably the best known among architects and builders of structural steel is the "Tockolith cement paint," which not only is damp-proof, but has the desirable quality of drying even when applied to moist surfaces. This paint is made up with a pigment which resembles closely portland cement, and is dependent on China-wood oil for its damp-proof qualities.

Another paint that perhaps is better known among naval officers, due to the excellent results it has given when applied to trimming tanks of submarines, is the "Rabok liquid-carbon" paint. This consists of a graphite pigment with metallic lead, and an asphaltic oil thinned with benzine.

Another paint which offers promise and for which its proprietors claim damp-proof qualities, added to the ability to adhere to moist steel and afford protection, is "Minwax." This is made from a mineral bituminous wax mined in Oklahoma, and thinned with bituminous oil distilled from the same natural substance.

"Lubrose" paints, which are made in Germany, have been tested and afforded good protection to the bilges of yard craft on which tested.

"Eureka" paint, which has given good service, where applied for test as a substitute for red lead, is made with a specially treated linseed oil, from which in all probability, the glycerin has been removed to render it damp-proof. The pigment is similar to venetian red, containing iron oxide, calcium sulphate and silica

The "Bitumo" paint has the same general characteristic as the bituminous materials, except that it can be applied cold with a brush like ordinary paint. On test it afforded excellent protection to steel plating in spaces where water was present continually.

While there are many other paints possibly as good or even better for the purpose than the ones mentioned, the writer's experience has been limited to these.

For ships already in service and on which red lead has been used in bilges, bunkers, trimming tanks and elsewhere, the best means of solving the difficulty apparently is to have recourse to a damp-proof paint until favorable opportunity offers for applying the bitumastic materials.

Another feature in connection with the use of red-lead paint that recently has been attracting attention is the question of lead poisoning which may be caused by its use. There have been numerous undoubted cases on shipboard and at navy yards, and precautionary measures are necessary and desirable to eliminate the possibility of serious effects on the men using lead paints or scaling surfaces that have been painted with them. The last phase of the question was regarded as being of enough importance to warrant the issuing by the Bureau of Medicine and Surgery of a special circular letter to all medical officers on the subject of lead poisoning, detailing its causes, symptoms and the precautions to be observed to prevent it.

An Ice-breaking steamer of peculiar design, for use in the harbor of Riga (Russia), on the Baltic, has been built at Goteborg, Sweden. Though only 182 ft. long overall, the depth is 27 ft. 6 in., with a draft of 21 ft. 4 in., so as to put the screws well below the line of ice. The beam is 50 ft. 10 in., and the displacement 1900 tons. From the water line, the bow slopes back at a flat angle, so that the keel length is only about 130 ft., and at the junction of the bow and keel (housed under the hull) is a small screw which serves to disturb the water and ice packs. This is driven by an engine of 1200 hp., while the main propelling screw is driven by an engine of 2500 hp. Both engines are triple expansion, and steam is supplied by four boilers. The designed speed is 12½ knots, but on the trial the vessel developed 14½ knots and 4000 hp. for the two engines. Flat surfaces are avoided, to reduce the liability of the vessel being caught in the ice, and numerous tanks formed in the hull provide for varying the trim of the vessel. In the ice tests at Riga, ice packs 25 to 30 ft. thick were dispersed by trimming the ship and by the work of the forward propeller, so that the ice breaker could go through the pack with only half its normal power.

Letters to the Editor

Closing Crevasses in Mississippi Levees

Sir—In your issue of June 13, p. 1125, Mr. Dabney makes this statement: "It is believed that the plan of building the open pile dike entirely around before doing anything else was first used by the writer in the upper Yazoo District in 1897."

This may have been the first time it was used in the upper Yazoo District, but it has been practiced by the Creoles as far back as we have any history of levees in Louisiana, and to my personal knowledge as far back as 1884. Julius Kruttschnitt, now Vice-President and Director of Maintenance and Operation of the Harriman lines, when Chief Engineer and Superintendent of Morgan's Louisiana & Texas R.R., successfully closed several breaks by this method, in the early 80's.

C. C. MALLARD,
Supt. Arizona Eastern R.R.
Globe, Ariz., June 19, 1912.

Destruction of Concrete between Tides in Sea Water

Sir—In your issue of May 30, 1912, p. 1029, John Stephen Sewell summarizes five papers presented to the International Navigation Congress, on the subject of reinforced concrete in hydraulic works, and draws therefrom certain conclusions as to concrete in sea water, which do not seem to me warranted by facts.

From New York along the Atlantic Coast northeast to Newfoundland, all the concrete surfaces in the intertidal space of which I have knowledge are disintegrating from freezing and thawing where washed by sea water, at the rate of from ⅛ in. to ½ in. per year. The accompanying halftone shows the concrete eaten in 12 in. in 20 years, and is only one of many examples which I could name. If all the similar cases known to me were photographed and spread out on the pages of ENGINEERING NEWS, none of your readers would be at all inclined to agree with Mr. Sewell, that "The objections to concrete in sea water are imaginary and must have arisen at a time when the subject was not so well understood as at present." It is useless to say that in these cases the materials have not been properly mixed; because the parts above high tide and below low tide are, as a rule, perfect.

I also take exception to the statement that "Concrete has been successfully used in permanent structures *everywhere*."

If concrete can be safely used *everywhere*, why are engineers just now speculating as to the cause of surface disintegration, as indicated by the article on the Lackawanna cement tests in ENGINEERING NEWS, June 13, 1912, p. 1111? Why are some engineers on the Atlantic coast building bridge piers and abutments of the best available stone, instead of concrete? Why are others building of concrete below low tide and above high tide, with stone between, and still others covering concrete with creosoted wood to protect its surface from contact with the sea water?

The engineering profession certainly does need to know *where* to put concrete, and where *not* to put it. The man who puts it *everywhere* is certainly borrowing trouble.

Mr. Sewell's own experiment, which showed corrosion of steel reinforcement in concrete mixed with sea water, is of great value, and his caution against using sea sand or sea gravel in reinforced concrete, is worthy the attention of every engineer.

WILLIAM B. MACKENZIE,
Chief Engineer,
Intercolonial Ry.
Moncton, N. B., June 17, 1912.

A CONCRETE WALL SERIOUSLY DAMAGED BY SEA WATER

(The view shows the disintegration of concrete surfaces between high and low tide marks in the Imperial Dock Yard at Halifax. Disintegration is about ½ in. per year, or 1 ft. in 20 years. The bottom part was repaired several years ago with vitrified bricks, which are standing perfectly, although the joints need repointing. The upper part of the wall is now being repaired with concrete blocks, the body of which is 1:2:4 concrete with a ½-in. facing of 1:3 mortar.)

The Engineer's Personal Responsibility

Sir—In the issue of ENGINEERING NEWS of the 6th inst., a matter of professional ethics is discussed. The question raised is whether or not an engineer should sign reports or plans which do not express his own conscientious and matured judgment.

The thing is often enough done, to be sure, and its expediency is generally beyond question, if the engineer wishes to keep his position. A recent case in the government service would seem to settle the matter of expediency. But can the dishonesty of such a course be questioned? The writer is unable to believe it.

If a lay executive or even superior engineering authority employs the training and ability of an engineer as an efficient tool through which to express his own views, by all means let him suppress—not hide behind—the engineer's name, and sign the reports or plans himself. There is no reason why trained and able assistance should not be utilized by anyone able to command it. A self-respecting man may sell to another his time or his labor, but not his name. This he should preserve strictly to witness the expression of his own conscientious labors, and his right to do this should not be questioned.

To the writer the matter seems simple. If the superior—lay or technical—is honest, two courses are open to him. He may receive the honest report of the engineer, properly signed, and approve or dis-

approve it according to his judgment or his interests. Or he may use the engineer as he would a comptometer or a typewriter, and sign the resulting document himself.

Journalism has come to a point in its evolution when the editorial page can hardly be expected to represent the views of the men who actually write the copy. These writers work to the line, but the superior authority takes the responsibility. In the same way an engineer might actually write a report in conflict with his private convictions (although this would certainly be particularly repugnant to one's self-respect) but to expect him or bulldoze him into lending his name to it is not merely dishonest but outrageous.

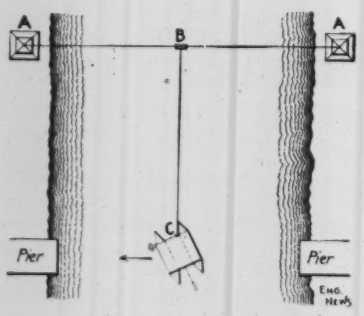
An engineer's good name is like any piece of property—he can't sell it and keep it too. Is it worth keeping? This seems to be the question.

GEO. S. BINCKLEY.

Los Angeles, Calif., June 12, 1912.

Still Another Ferryboat Propelled by the Current

Sir—The article in your issue of May 30 by C. E. Chappell reminded me of another ferryboat, based on a similar principle, though worked out in a somewhat different manner, which might interest some of your readers. I saw it a few years ago in the southern part of Austria and believe that this way of crossing the river has been in use since about 1850.



The river at the point of crossing is about 400 ft. wide and the current is rather swift. The accompanying diagram shows the arrangement of the ferry. A 1½-in. cable is stretched across the river on two towers *A-A* and along this runs a carriage *B*, connected by another cable about 200 ft. long to the ferryboat at a point *C*. The ferry itself consists of two flat-bottom boats each about 40 ft. long, and covered by a platform big enough to hold four teams. The connecting cable is fastened to one of the cross-bars separating the two boats and is shifted from left to right on this bar, depending on the direction in which the ferry is supposed to travel. A rudder, attached to a long pole at the rear of the ferry and manipulated by the ferryman (or his wife) facilitates the starting of the boat from the landing place, by giving sufficient resistance to the current to bring the ferry into the desired slanting position. This also adjusts the position of the cable connection at the point *C*. As can be seen on the diagram the current, striking the sides of the two boats forces the ferry to move in the direction of the arrow, and the carriage *B*, rolling on the cable, follows easily.

This ferry is in commission about ten months in the year, needs hardly any repairs and works most satisfactorily and economically.

H. VON WETTER.

331 Madison Ave., New York,

June 19, 1912.

[As the letters published in our issues of June 13 and 20 testify, ferryboats of the traveling cableway type are both old and numerous. We give space to the above letter, however, since the ferry there shown appears to have the detail of the connection between the boat and the cableway particularly well designed.—ED.]

Engineering Graduates and the World

Sir—Apropos of the occupational summary of graduates contained in Prof. Charles H. Benjamin's interesting article on "The Engineering Graduate and the World" in your issue of June 6 I am inclosing herewith a somewhat similar classification that has just been made of the graduates of the engineering departments of the University of Pennsylvania.

It is particularly interesting to note the close agreement (67.2 and 65.2%) between the percentages of graduates engaged in engineering from among the graduates of the Civil Engineering Department, as against the Mechanical and Electrical Engineering Department, and the similarly remarkable agreement (85.7 and 87.9%) between the percentages of graduates engaged in engineering and kindred pursuits among the graduates of Civil Engineering Department as compared with those in the Mechanical and Electrical Engineering Department. The last group includes also a few graduates in chemical and mining engineering, but their number is comparatively small. The course in mining engineering at "Pennsylvania" was abandoned some twenty years ago. The award of certificates of proficiency for technical work in the engineering departments, of which the total is 62, was discontinued many years ago. It may be of interest to add, that of the total number of graduates, 1258 beginning with the class of 1873, more than one-half have graduated since 1904.

EDGAR MARBURG,
Professor-in-Charge.

University of Pennsylvania, Department of Civil Engineering, June 11, 1912.

CLASSIFICATION OF GRADUATES (492) AND HOLDERS OF CERTIFICATES OF PROFICIENCY (39), DEPARTMENT OF CIVIL ENGINEERING

Civil engineering:		
General and consulting	20	
Government	12	
Hydraulic and sanitary	22	
Inspecting	11	
Landscape	2	
Municipal	42	
Railroad	113	
Reinforced concrete	16	
Structural	69	
Teachers	11	
		318
Electrical		[illegible]
Metallurgical		[illegible]
Mining		[illegible]
Total in engineering		334
Pursuits related to engineering:		
Architecture		
Contracting		32
Manufacturing		
		92
Total in engineering and related pursuits		426
Other professions:		
Army	1	
Clergy	3	
Law	10	
Medicine	12	
Teachers (nonengineering)	11	
		26
Miscellaneous:		
Agriculture	4	
Mercantile business	34	
Students	12	
		49
Retired		5
Deceased and unknown		34
Total		531
Percentage of graduates engaged in engineering*		67.2
Percentage of graduates engaged in engineering and kindred pursuits		85.7

CLASSIFICATION OF GRADUATES (704) AND HOLDERS OF CERTIFICATES OF PROFICIENCY (23), DEPARTMENT OF MECHANICAL AND ELECTRICAL ENGINEERING

	Courses				
	Mechanical	Electrical	Chemical	Mining	
Commercial	25	4	0	1	
Gas	49	9	4	0	
General and consulting	13	7	1	2	
Government	0	0	3	0	
Hydraulic	3	2	0	0	
Inspecting	7	4	1	0	
Light and power	9	15	1	0	
Manufacturing	81	28	27	2	
Municipal	7	3	0	0	
Railroad and railway	22	12	1	0	
Teachers	12	5	0	0	
Telephone and telegraph	6	29	0	0	
	234	118	38	5	395
Civil	0	1	0	1	
Metallurgical	1	0	1	1	
Mining	3	1	0	5	
Structural	1	0	0	0	
	5	2	1	7	15
Total in engineering					410
Pursuits related to engineering:					
Architecture	4	0	0	0	
Contracting	11	5	0	0	
Manufacturing	75	37	7	3	
	90	42	7	3	142
Totals in engineering and related pursuits					552
Other professions:					
Clergy	3	0	0	0	
Law	2	0	0	1	
Medicine	2	0	0	0	
Navy	2	0	0	0	
Teachers (nonengineering)	6	7	2	2	
	15	7	2	3	27

*Omitting deceased and unknown.

Miscellaneous:					
Agriculture	1	0	0	0	
Financial	7	0	0	0	
Government work	3	0	0	0	
Mercantile business	13	11	3	3	
Students	2	1	0	0	
Retired	5	0	0	0	
Deceased and unknown	66	16	6	11	
	97	28	9	14	148
Total					727
Percentage of graduates engaged in engineering*					65.2
Percentage of graduates engaged in engineering and kindred pursuits*					87.9

A Bridge in War

Sir: The accompanying three views show a bridge which has lately been dynamited by the Revolutionary forces. The bridge is at the crossing of the Mexican Central R.R. over the Conchos River about three kilometers north of Santa Rosalia; it was shot on the night of May 27. At this time the Reds were in retreat toward Chihuahua and they, presumably, wrecked the bridge in order to delay pursuit by the Federals, who are now occupying Santa Rosalia as their headquarters.

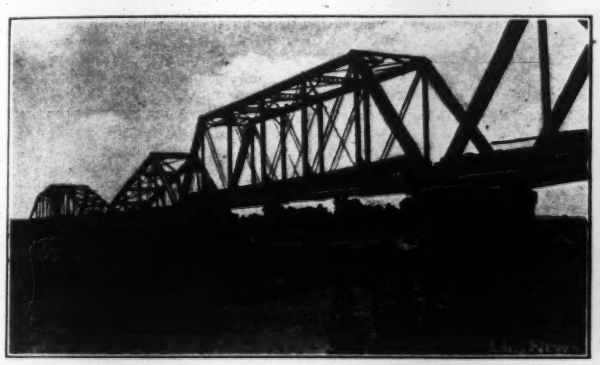


FIG. 1. VIEW FROM UPSTREAM SIDE

FIG. 3. PIER BETWEEN DAMAGED TRUSSES

CONCHOS RIVER BRIDGE, MEXICAN CENTRAL R.R., NEAR SANTA ROSALIA, AFTER BEING DYNAMITED BY RETREATING ARMY

(Federal soldiers camped under bridge in Fig. 1.)

FIG. 2. TWO DAMAGED TRUSSES AND DAMAGED LEFT ABUTMENT

High water, which is now somewhat overdue in the Conchos, will make the repair of the bridge quite difficult unless the work be done promptly, but we understand that a very able engineering force is close behind the Federals and that the railway system is being put into working order rapidly.

In spite of its appearance, the bridge is not greatly damaged. Two piers have their tops shot off, and the left abutment is somewhat damaged. The ends of two trusses are badly bent and somewhat broken, but should be readily put into shape in a short time.

It has been remarked that very much more damage might easily have been done with the three half-box charges of dynamite which were exploded (one each on the tops of the two piers and one on the left abutment); but it is very possible that the Reds did not want to damage the bridge any more than was really necessary to cause delay.

S. C. HULSE, Asst. Engr.,
Mexican Northern Power Co., Ltd.
Santa Rosalia, Chi., Mex., June 10, 1912.

Is the Reinforced-Concrete Column an Economic Failure?

Sir—The writer has been much interested in articles appearing in ENGINEERING NEWS from time to time relative to reinforced concrete. He is especially interested in the article in your issue of June 6, 1912, entitled "Concrete Column Economics," by J. Norman Jensen.

As Mr. Jensen states, it is very frequently asserted that the cheapest reinforcement for a concrete column is cement. That this is a fact seems to be borne out by experiments and also by theory, although the theory, of course, is necessarily based upon the experiments.

As long ago as Oct. 23, 1902, ENGINEERING NEWS published an article by the present writer relative to the filling of structural-steel columns in the new Government Printing Office with concrete. The probable stiffening and other beneficial effects of this treatment, including resistance to fire, were discussed in that article and also in an editorial in ENGINEERING NEWS of the same date.

In the article of Oct. 23, 1902, the writer expressed the opinion that from a concrete-filled steel column to a reinforced-concrete column was only a step and expressed the opinion that the reinforced-concrete column might be the final solution. He desires now to retract that opinion, as in the light of later progress and experiments he is convinced that the real, final economical solution of the column question in buildings, if not in all other structures, lies in the direction of a structural-steel column reinforced with concrete.

Bulletin No. 56 recently issued from the University of Illinois bears directly on this subject.

In *Concrete and Constructional Engineering* for June, 1912, is a description of what are practically cast-iron columns reinforced with concrete, by Dr. F. von Emperger.

After a great many theoretical investigations and a study of all the experimental data that have come into the writer's possession on the subject of reinforced-concrete columns, he has become convinced that in a reinforced-concrete building, the column is the least economical feature; in fact, it seems doubtful whether it is economical at all, and in some structures for which the writer made preliminary designs he would finally have abandoned the idea of reinforced-concrete columns altogether but for the fact that it was desired to use reinforced concrete throughout. It is not his purpose to enter into any lengthy discussion of this subject at this time, but he will content himself with saying that as a result of studying the effects of the San Francisco and Baltimore fires and the experimental data on reinforced-concrete columns that have been available in recent years, he has become convinced that the final solution of the column question is, as above stated, in the direction of a structural-steel column reinforced and fireproofed with concrete. It seems probable that in that direction will be found the solution which will finally give the greatest sum total of resistance to structural stresses and fire, for a given amount of money, and that

it will also result in columns of the slenderest possible proportions consistent with safety.

The writer still believes that burnt clay products made of the *right kind of clay, in the proper manner* and *properly applied* are the most resisting of fireproof materials; but within practicable limits of cost in commercial buildings more fire protection can be secured for a dollar with concrete than with burnt clay products. As for the actual reinforcing effect of the concrete filling in a steel column the result of the experiments described in Bulletin No. 56 are extremely encouraging.

At the present time the column in the modern building is the least satisfactory structural member in use; yet it is the one that ought to be the most reliable. It appears to the writer that no one limited field of structural investigation promises such far-reaching and beneficial results as this which has been opened up in Bulletin No. 56 of the University of Illinois. Mr. Jensen's investigations lend force to this statement. The most efficient reinforcement of the concrete column seems to be cement. But no one is ever going to use columns of cement alone, without reinforcement to prevent buckling. In the writer's judgment, a properly designed steel column, reinforced with concrete, can be installed at less cost than one of reinforced concrete having the *same factors of safety against both stress and fire.*

JOHN STEPHEN SEWELL,
Late Major, Corps of Engineers, U. S. Army.

Gantt's Quarry, Ala.,
June 19, 1912.

[Bulletin No. 56 of the University of Illinois referred to by Maj. Sewell is entitled "Tests of Columns: An Investigation of the Value of Concrete as Reinforcement for Structural Steel Columns," by Arthur N. Talbot and Arthur R. Lord. It is much too lengthy for anything more than a brief description here, together with a reprint of the conclusions reached by the experimenters. Interested engineers are referred to the bulletin itself for further study.

The tests were made on four types of columns, viz., (1) plain steel columns of the Gray type; (2) plain steel columns (Gray type) filled in up to the flanges of the outside angles with concrete, called here the "core type"; (3) columns similar to (2) but with an extra 2 in. of surface concrete, called the "fireproofed type" and (4) columns similar to (2) but with the steel encased by spirals and concrete filled in to the outer diameter of the spirals, called here the "spiraled type." Types (1) and (2) were in lengths varying from 2 ft. to 10 ft. and types (3) and (4) were of 10 ft. and Variation in quality of concrete and percentage of spiraling was made. Tests were made in compression on the columns up to the elastic limit of the material.

The bulletin contains some 44 pp. descriptive of the work and a brief summary which we reprint as follows:

GENERAL COMMENTS—The columns tested were of a form now frequently used in building construction. The percentage of steel used (area of steel section 10.8% of the area of the octagon inclosing the structural shapes) is within the range used in building construction. The conclusions given in the discussion relate to the properties of columns which have the forms and sections of the columns tested, and variations in proportions of metal and concrete may give somewhat different results. The tests, however, may be expected to throw light on the properties of columns of the same general type within the limits of ordinary design. The principal conclusions found in the discussion are as follows:

1. The maximum load carried by the plain steel columns is expressed by the straight-line formula,

$$\frac{P}{A} = 36{,}500 - 155\frac{l}{r}$$

where $\frac{l}{r}$ is the ratio of length of column to radius of gyration of the section of the steel column.

2. Earlier in the test the effect of length upon load carried at a given unit-deformation was less proportionately than at maximum load, the coefficient of $\frac{l}{r}$ in the equation being only 55 for a unit-deformation of 0.0008, and 27 for a unit-deformation of 0.0005, as compared with 155 in the equation for maximum load.

3. The load-deformation diagrams diverge from a straight line at loads well below the maximum.

4. In the concreted columns of the core type, the effect of length upon strength of column was almost identical with that found in the tests of plain steel columns. In other words, the stress taken by the concrete may be considered to be nearly independent of the slenderness ratio of the column, within the limits of the lengths tested, and the stress taken by a plain steel column of the same slenderness ratio.

5. In the tests the concreted columns of the core type showed considerable toughness, though at the maximum load there was no material lateral deflection. The final failure of the concrete generally occurred at or above tie plates. The discussion shows that the concrete of the columns was less strong than the concrete of the cubes and less stiff than the concrete of the cylinders.

6. The stress taken by the concrete within the core or within the spiral is approximately equal to the strength of concrete of the cylinders tested and to two-thirds of the strength found in the 6-in. cubes.

7. The values of the ratio of the modulus of elasticity of the steel column to that of the concrete, n, under the assumptions used in the analysis, are much larger than are commonly used in reinforced-concrete design.

8. A basis for design which seems rational is to determine the strength of the steel column by the use of the column formula for the $\frac{l}{r}$ of the steel column, and then to consider the concrete of the core section (without reference to the length of the column for any ordinary length ratio, say a length of 15 diameters) to have a stress value proportional to the strength of the plain concrete, say two-thirds of the cube strength. A suitable factor of safety would, of course, be somewhere applied.

9. In the test of the fireproofed type of column (which had a shell of concrete outside the steel) the concrete shell remained intact until a deformation was reached as great as that developed at the maximum load in columns of the core type. This integrity of section at high deformation indicates that the presence of the shell need not impose any restrictions upon the working stresses available for the steel and for the core concrete. Of course, there are good reasons for the use of a metal binder like wire mesh or spiral for holding the shell securely in place.

10. The discussion indicates that the stress carried by the concrete of the shell is only about half of that carried by the core concrete. This lower strength is not objectionable, since the shell is not considered in designing the column.

11. The action of the spiraled columns indicates that the spiral has little effect up to a deformation and load corresponding to the maximum load for an unspiraled column. Beyond this load the column compresses rapidly and the presence of the spiral adds materially to the strength of the column. The tests do not fix the exact amount of this added strength.

12. In view of the large shortening necessary to make the added strength due to spiraling available and the general toughness of columns of the core type, it would seem that for building construction the use of a large percentage of spiral reinforcement in columns made up of structural shapes and concrete is hardly justifiable. A moderate spiral may warrant the use of somewhat higher unit-stresses, since it adds to the toughness of the column and gives a possible higher ultimate strength, and it will also serve to tie the concrete of the shell together securely and protect it from accident, but it does not seem best to consider this spiral directly in the computations for strength of column.

13. The columns tested possess the qualities of a good structural member and seem well adapted to more general use in building construction.

These comments are made on the assumption that the concrete is placed in as workmanlike a manner as is obtainable in the construction of high-grade work in columns reinforced with longitudinal rods or with rods and spirals.—ED. ENG. NEWS.]

Notes and Queries

H. C. W., San Francisco, writes: I should be glad to know of any examples of local ordinances restricting the whistling of railway locomotives within the corporate limits of municipalities.

Our attention has been called to an error in two of the stated dimensions in the equipment of the dredge "Turbine," described in Engineering News, June 13, 1912. The dredge is reported to us by one of its designers to have a 22-in. suction instead of a 20-in., and the mean draft is about 7 ft. instead of 12 ft.

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Engineering News

Double Tracking the Canadian Pacific Railway through the Rocky Mountains

It was recently announced by Sir Thomas Shaughnessy, the President of the Canadian Pacific Ry., that that railway has plans is progress for double tracking its line through the Rocky Mountains. The estimated cost of this work, $60,000,000, calls attention to the remarkable growth of traffic in a region which only a generation ago was an uninhabited wilderness. There are many men in active life who can recall perfectly the circumstances in connection with the construction of the Canadian Pacific Ry., but to the younger generation of our readers it may be of interest to record the great difficulties which were experienced in obtaining the capital for the original construction of this road.

Agitation for the construction of a Canadian transcontinental railway became active about the time of the completion of the first transcontinental railway in the United States—the Union Pacific—in the early '60's. The union of the Canadian provinces under the Dominion Government made necessary for political reasons the construction of a railway to connect the Pacific Coast with the great prairie region in the center of the continent, whose wonderful future prosperity was hardly dreamed of by the older provinces of the East.

The Canadian government at first undertook to build the road itself. It completed a line to the Fraser River, British Columbia, and from the head of Lake Superior to Winnipeg, a total of about 650 miles. The difficulties of the work through the Rockies were so great, however, that it was decided to turn over the enterprise to private capital. In 1880 a contract was made with the Canadian Pacific Ry. Co. to complete a line from Fort William at the head of Lake Superior eastward to the Ottawa River, and from Winnipeg westward to Fraser River Canyon, a total distance of about 2100 miles. The government turned over to the company the lines already built as a free gift and gave it in addition a subsidy of $25,000,000 and a land grant of 25,000,000 acres. The land granted had at the time, of course, only a nominal value, though today it is worth considerable. The company was given 10 years to complete this work, but it attacked the task with such energy that the whole line was open to traffic from Vancouver to Montreal within 4½ years from beginning work.

That the management of the company has been excellent from the beginning, and that its securities have in consequence long occupied a premier position among all American railways is very well known. It is indeed remarkable, however, that traffic on the mountain section of the line which was for many years a drag upon the rest of the system has now attained such dimensions that it has become necessary to increase its capacity by double tracking.

Percolating Sewage Filters to Enter Massachusetts

The idea has long been held by many that any other system of water purification than slow sand filtration and any other method of final sewage treatment than intermittent sand filtration could never gain entrance to Massachusetts. Whatever warrant there may have been for this belief, there is now prospect of the early use of percolating or sprinkling filters at both Fitchburg and Brockton, plans including such filters having been approved for each place by the Massachusetts State Board of Health. At neither place, however, will percolating filters be the main dependence.

At Fitchburg plans made by Metcalf & Eddy, of Boston, provide for Imhoff clarification tanks, percolating filters, secondary tanks of some kind and, finally, sand filters. About a third of the ultimate installation contemplated will be built at present, thus giving an opportunity to profit by experience when building the remainder of the plant.

At Brockton, the plans of B. R. Felton, City Engineer, provide for percolating filters to lighten the work of the existing sand beds. There is plenty of good sandy land available for extending the sand beds but a trial of percolating filters will be made.

The Massachusetts State Board of Health has experimented at Lawrence with percolating filters and may be counted on to study the results obtained on a large working scale at Fitchburg and Brockton. As the Board has never demanded sewage purification to a radical degree, it may be expected that if the proposed percolating filters mentioned are a success the Board may in due time approve plans in which the chief reliance will be upon percolating filters—provided, of course, that a higher degree of purification than can thus be obtained is not deemed essential.

A City without Local Municipal Contractors

Few if any of the larger cities of the United States have had so long and extensive an experience with constructing public works by direct labor as has Minneapolis. According to Andrew Rinker, City Engineer, this experience, at least on a large scale, began in the 80's, when the lowest bid for sewer construction was $40,000 above his estimate. The city council assumed a critical attitude. This led Mr. Rinker to volunteer to back up his estimate by carrying out the work with city men. The outcome was so satisfactory that the same practice has been extended from sewers to paving and to water-works construction, including the building of a pumping station and even so extensive a piece of an improvement as the new filtration plant and covering of a large reservoir basin, now underway (see ENG. NEWS, Jun. 27, 1912). Altogether some two thousand men are on the city payrolls.

The direct labor plan has met with the general approval of the citizens. The work costs no more, Mr. Rinker states, than if done by contract, and the workmen get higher wages. Inspection problems are simplified. Greater freedom can be exercised in adapting materials and methods to special conditions, as they arise, than is possible under the contract system.

A recent examination of many of the paved streets of Minneapolis by a member of the editorial staff of this journal led to the conclusion that the day-labor system results in good construction and maintenance of street pavements. The use of traveling concrete mixers and spreaders for putting down concrete foundations for pavements indicated that labor-saving devices are not barred by the day-labor system. A saving of, say, 3c. per cu.yd. (12 to 9c.) for mixing and placing by the traveler as compared with hand mixing and placing was reported by E. R. Dutton, assistant city engineer in charge of pavements.

From the facts and opinions just stated it would appear that Minneapolis would be an interesting place for a detailed study of methods and costs of the day-labor system; such, for instance, as was made in Boston by Metcalf & Eddy a few years ago. We do not mean to suggest, however, that the conclusions drawn from such a study in Minneapolis would be so unfavorable to the day-labor system as were the conclusions at Boston.

It is particularly interesting to note that there are no contractors in Minneapolis engaged on local municipal work. Such a condition would probably be hard to match elsewhere. Possibly an occasional bid on paving or sewer or water-works construction would be a useful check on the cost of the day-labor system. Perhaps such bids are asked from time to time.

The Locomotive-Boiler Explosion at San Antonio, Texas

We summarized in our issue of June 20, the report of the Interstate Commerce Commission's inspectors on the disastrous locomotive-boiler explosion of Mar. 18 last at San Antonio, Tex., by which 26 persons were killed and 32 were injured. The conclusion of these inspectors was that the explosion was due to the work of an employee who was adjusting the safety valves on the locomotive at the time and who was killed in the explosion. It is their belief that the steam gage was seriously in error, so that a heavy overpressure was accumulated in the boiler while the safety valves were being adjusted by the defective gage. Following this report by the Interstate Commerce Commission's inspectors, however, a statement has been issued by Mr. Thornwell Fay, president of the Harriman Lines in Texas and Louisiana, in which evidence is presented supporting the theory that the disaster was due to the setting off of some high explosive in or adjacent to the boiler. Mr. Fay states that following the explosion the railway company appointed a board of inquiry, among the members of which were three Army officers familiar with high explosives and four railway motive-power officials. The members of this board radically disagreed in their opinions as to the cause of the disaster, four of them assigning the explosion to excessive steam pressure and two to low water. One of the Army officers considered that the explosion "was due to some unusual and extraordinary cause."

Mr. Fay states that his own investigation in connection with other officials of the company shows that the injectors on the boiler were working shortly before the explosion. The manufacturers of the injectors state that the injectors will not operate above a pressure of about 240 lb., and Mr. Fay submits evidence of a professional boiler inspector who declares that a pressure far higher than this would have been required to have burst the boiler. He also states that one of the locomotive driving-axles, 9½ in. in diameter, was broken short off by the explosion. On the basis of these facts, together with the circumstantial evidence that in connection with the strike then in progress on the Harriman Lines, many acts of vandalism were perpetrated on the railway property and machinery, Mr. Fay submits the probability that the disastrous explosion was due to the discharge of dynamite or some other high explosive in or close to the boiler.

Railway Baggage Handling

Not long ago a man of some note proclaimed that the railways of the United States could save millions of dollars annually by managing their affairs and operations more "scientifically." We are reminded in this season of summer travel that a more modest but yet very considerable saving could be effected without any remarkably "scientific" management. It is true that this saving would revert to the public pocket rather than to the railway treasury, which fact does not, however, decrease the importance of the matter. We refer to the saving that would result from elimination of the systematic trunk-smashing now practiced universally by railway employees.

Millions of trunks are handled each day on our railway lines. Of these, many thousands are destroyed — and needlessly destroyed. The destruction benefits no one; it does not advance the interests of the railway; on the contrary it makes enemies by the thousand, who will delight at the first opportunity to get even.

The railway baggage department has to deal chiefly with trunks and bags. Bags, being lighter and essentially non-rigid, are relatively more robust than trunks. Our remarks, therefore, are restricted to the latter, though much might be said on the kind of treatment to which bags are subjected. Besides, the traveler may (and if he is a wise traveler, does) carry his bag, while trunks must of necessity be handled by baggagemen.

The current method of handling and transporting baggage requires, among other things, that each trunk must be lifted from station platform to car, and later must be lowered from car floor to station platform. The lifting process is of no special interest here. The "lowering" is the source of the damage. In the generality of cases it is done by simply dropping each piece of baggage as nearly vertically as possible, the height of 3 to 4 ft. from car floor to station platform.

A fall of 3 or 4 ft. means a striking velocity of 13.7 to 16 ft. per second, or 9 to 11 miles per hour. When a railway car standing on a track is struck by another moving at a speed of about 10 miles per hour, the effect is about the same as in the fall of the trunk. Col. B. W. Dunn has shown by experiments that such collisions between freight cars do great damage to the contents of the cars. In the automatic coupling of cars, even when done at much lower speed, down to five miles per hour, the lading will be shifted and smashed unless tightly blocked and fastened in place. His studies, which had reference to the safe transportation of explosives (a class of freight whose injury or destruction is apt to damage railway property), resulted in the formulation of stringent rules for the loading and blocking of packages of ex-

plosives. The purpose of these rules is to make shipments of explosives safe against the shock produced in coupling cars at speeds not greater than about five miles per hour. Protection against rougher handling than this is found to be virtually impossible. Even some shipments loaded in approved manner showed considerable smashing when exposed to collision at speeds not greater than 10 miles per hour; strong wooden boxes of dynamite were broken and crushed. Yet a treatment of equal severity is daily meted out to practically all trunks handled on railways, and railway officers appear to believe that trunks can (or should) endure such treatment with no particular injury.

Anyone may readily check up the above observations and figures, and refer to Col. Dunn's experiments; he can thus deduce the fact that every trunk making a baggage-car journey is subjected to violence which suffices to break and crush a dynamite box. Many trunks succumb under this treatment. That any of them survive is little short of a miracle. Their survival is due largely to the fact that the elasticity of the trunk itself and the compressibility of its contents, acting together, reduce the impact pressure somewhat below that developed in firmly-packed car lading.

Generally speaking, there are two variations of procedure in dropping trunks, we find from observing current practice. They are (1) the corner-drop method, and (2) the square-drop method, both of which have their partisans. From the viewpoint of the trunk owner they are practically equivalent, gaged by their effects, though they may differ in their appeal to the trunk handler.

The first method consists in guiding the fall of the trunk in such a way as to land it on one of its corners, with the center of gravity as nearly as possible in line of the fall so as to give a dead fall free from skipping or bounding. Lack of skill sometimes results in bringing the impact on the trunk's edge instead of on its corner; this gives a shearing stress in the structure of the trunk, whose destructive action is materially different from the rending and splitting effect of the corner blow. It may be remarked, incidentally, that a trunk landed dead on its corner can be swung sidewise out of the way in a single movement with minimum effort, while the edge landing necessitates a separate jerk to swing the trunk around.

The square-drop method requires that the proper poise of the trunk on the edge of the car floor must first be secured; then by a slight outward swing or lurch the trunk is projected into space in such a way as to reach the ground flat on its end (or side, or bottom) and stop dead on the spot. The movement requires no guiding if started skillfully enough, and this is its chief merit. In its actual effect the impact is distributed more equally between trunk and contents than in the first-mentioned method; the contents are shucked down very forcibly in the direction of the fall. Fragile articles in the trunk rarely survive.

It is of interest to refer to the baggage truck as a factor connected with baggage handling. Theoretically the baggage truck ought to reduce the damage in baggage handling. As practically used, however, it makes a bad matter worse. At stations where the station agent is the sole attendant, trunks are never unloaded onto the truck. The train baggageman simply fires the trunks onto the platform in the shortest possible time so that the train may get away. The stationmaster is busy selling tickets and doing seventeen other things at the same time when the train arrives, so he has no time to bring the baggage truck around to the car.

The baggage truck is only used, therefore, at junction or terminal stations where large amounts of baggage are handled. Here the trunks are piled on until the top tier is 8 or 10 ft. above the platform, and when the uppermost trunks are dropped on the platform, heaven pity the passenger who has packed liquid refreshments or delicate bric-à-brac inside his trunk.

It is a fair question to raise, we believe, whether the time has not arrived for a reform in the time-honored system of baggage smashing. The railways are spending millions of dollars to stimulate passenger traffic by providing in countless ways to make journeying pleasant and comfortable. It is merely a case of neglect and official inertia that nothing has been done before this to promote the careful handling of baggage, and thereby reduce the large number of damage claims and the far more numerous cases where the owner of a damaged trunk puts in no claim but harbors a grievance against the railway company.

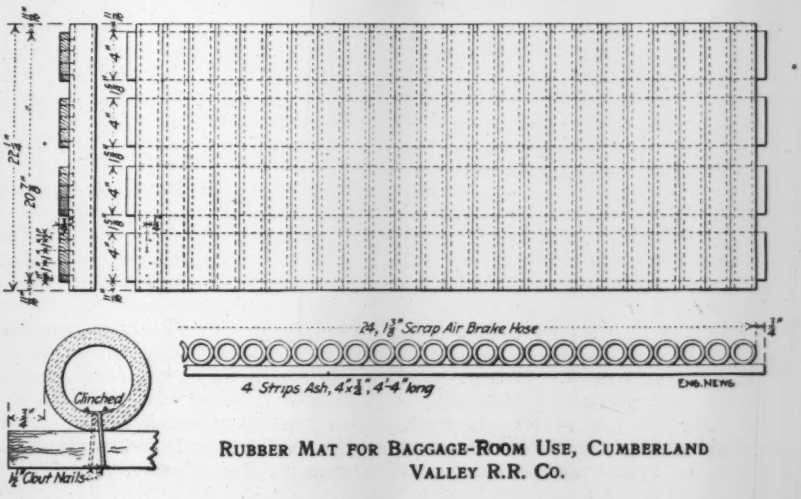
Admittedly the problem presents difficulties, for baggage must be handled at most points in the shortest possible time. It is not reasonable to believe, however, that the problem is unsolvable. Nor is it reasonable to suppose that when mechanical appliances have revolutionized operations in so many fields of industry that in baggage handling alone, the sole reliance must forever be on main strength and awkwardness.

As proof that some attention is being paid to this problem, the elastic mat for baggage rooms, developed on the Pennsylvania lines and illustrated below, is of interest. Perhaps somebody, somewhere, sometime, may venture on the radical innovation of putting springs under the floor of a baggage truck. A folding chute from a baggage-car door might be devised that would ease the lowering to the station platform. We present these merely as suggestions of possible methods of improvement. The matter is worth the thorough study of a special man to be detailed for that particular task on some of our great railways. Attacked in this way, we are confident that brains can be successfully applied to save baggage.

A Baggage Cushion for Protecting Trunks

The Cumberland Valley R.R. (Pennsylvania system) has made a radical innovation in handling baggage by providing elastic cushions on which to drop trunks in unloading them from baggage trucks. The drawing herewith shows the design, drawn up in the office of the master mechanic at Chambersburg, Penn. (T. Hamilton). It is reported that these cushions "have proved very efficacious in protecting trunks."

The cushion is 22¼x52 in. It is made of pieces of scrap airbrake hose mounted on four strips of ash, 4x¾ in. The method of attaching the hose by nails clinched inside is shown in the drawing. An iron bar pushed into the hose when driving the nails does the clinching.



RUBBER MAT FOR BAGGAGE-ROOM USE, CUMBERLAND VALLEY R.R. CO.

Annual Convention of the American Society of Civil Engineers

The forty-fourth annual convention of the American Society of Civil Engineers was held at Seattle, Wash., June 25 to 28, 1912. Considering the fact that the Society has a total membership of 6500, the attendance of about 150 was very small. This was partly accounted for by the distance of Seattle from the center of gravity of the membership. But the engineers of the Far West are accustomed to long distances and the membership in the Pacific and Rocky Mountain States runs into the hundreds and there are 135 members in the State of Washington alone. The conclusion therefore must be drawn that pleasant as the summer meetings unquestionably are, and this one was notably pleasant, they appeal only to the fortunate few who can spare the time and the money to take a summer outing, renew old and make new acquaintances, and hear a few addresses designed chiefly to entertain and to give general information rather than to impart technical instruction.

It is interesting to note that the summer meetings are as notable for the absence as are the fortnightly meetings in New York for the presence of the younger members of the Society.

Some fifty members and guests journeyed from Chicago to Seattle together over the Chicago, Milwaukee & St. Paul, with Chief Engineer Charles F. Loweth in the company to point out the chief features of this route. Seattle was reached Sunday evening. This left Monday a free day. That evening there was an informal reception, followed by a lantern-slide talk which impressed on those present the natural resources of Alaska, including its wonderful scenery. On Tuesday evening there was another very interesting lantern-slide talk, this time on Mt. Rainier.

The general plan of the convention was papers or business in the morning, an excursion in the afternoon, and illustrated talks in the evening. Besides minor trips to the University of Washington and other purely local points there were excursions to the Bremerton Navy Yard; to Tacoma, where the visitors were entertained by the Tacoma members; and finally, on Friday, the choice between all-day excursions to Mount Rainier National Park and Nisqually Glacier, the Nisqually and Electron power plants, starting the midnight before; (2) Victoria, B. C., by steamer; (3) Sol Duc Hot Springs, in the mountains, extending to 2:30 a.m., Sunday. The various trips in and beyond the city were provided by the local members and the citizens of Seattle and vicinity, and by the Pacific Northwest Engineering Society, with Tacomans assisting, as already stated. Besides all this, members at Portland, Ore., offered entertainment in that city on July 1.

Addresses of welcome were delivered at the opening session by Mr. Lee, of the State Public Service Commission, representing Governor Hay; by Geo. F. Cotterill, mayor of Seattle, and J. W. Spangler. Mr. Lee paid a compliment to the work of engineers in connection with public-service commissions. Mr. Spangler, a Seattle banker, said that in the end the banker finds no opinion in which he places more reliance than that of the engineer.

Mayor Cotterill, himself an engineer, in the course of a telling address, said that in the 28 years he had lived in Seattle he had seen the city increase from 7000 population to nearly forty times that number and in area from a thousand acres in the forest to 58 sq.miles surrounded by thriving suburbs. In all the marvelous growth of Seattle the engineer has been the pathfinder and leader.

President's Address—The address of President J. A. Ockerson touched first upon notable statements in earlier presidential addresses, including remarks by Octave Chanute in which he predicted that the time would come when men would sail through the air.

The main theme of Mr. Ockerson's address was the relation of the Society to the welfare of its members. The Society should do more to mold public opinion and to make membership in the Society significant. Speaking of the proposal to license engineers, Mr. Ockerson stated that the only value of this to anyone would be to the public; and that membership in the Society is a far better guarantee to the public than any license could be.

As a means of increasing the usefulness of the Society to its members, Mr. Ockerson suggested that some plan be devised under which meetings would be held outside of New York more frequently than now. Although the membership of the Society has greatly increased, attendance at conventions has decreased. District meetings were suggested; also the holding of the annual convention in the several districts in rotation, each district to choose the meeting place within its borders.

Papers and Discussions

Ports of the Pacific—In a characteristically able paper prepared by Gen. H. M. Chittenden, of Seattle, and read for him in his absence, the main features of the leading and secondary ports of the Pacific were described and compared, the effect of the Panama Canal upon the Pacific Coast States was discussed and a strong plea was made against charging tolls for the use of the canal—the plea being qualified as stated below.

The California ports of San Diego, Los Angeles and San Francisco have little to fear from northern competition, and likewise Portland need not fear competition from the California ports. Between the Northern ports much rivalry is to be expected.

Whatever the future may show, San Francisco is the leading port of the Pacific today. Nature wrought a wonder when she formed San Francisco Bay and in point of time San Francisco led all the Pacific ports in development. Los Angeles is incontestably the commercial center of southern California. Its harbor, though largely artificial, will be one of the great harbors of the world.

Portland, by means of the Columbia River, is the only city of the Pacific Coast which has a water-grade connection with the East. The locks on the Columbia are a handicap to its navigation and a handicap to the port is caused by the bar at the mouth of the Columbia. This bar is one of the most formidable to be dealt with by harbor engineers. The river from Portland to the bar must be deepened.

The Puget Sound ports are strategic, but have drawbacks, including their tidal range, and the mountain passes to the eastward, with a minimum elevation of 3000 ft. to be overcome by rail. Tacoma, 30 miles to the south of Seattle, with a harbor that rivals that of Seattle and favorable railway facilities, is a formidable rival of Seattle. At the North, Seattle is rivaled by Vancouver, but the harbor of the latter is inferior to those of its Southern competitors. Prince Rupert, beyond the Puget Sound region to the North, is 500 miles nearer Asia than any other Pacific port.

The probable effects of the Panama Canal on the Pacific Coast were discussed as regards consumption and production, population, commerce and industry. The effect on population through immigration will probably be the most important of all the effects. Steps to secure a good quality of immigrants should be taken. The effect of the Panama Canal on Pacific Coast industries is a much disputed question. The preparation for increased shipping facilities to meet the opening of the canal is probably being greatly overdone.

The day for tolls on public highways having passed, there should be no tolls on the Panama Canal. Every dollar collected in tolls must be paid in some other way and will restrict trade. Congress has wisely recognized this as regards home traffic. Some plan should be devised by which the other countries of the world would pay their share of the cost of building the canal, thus making it just to the United States, which is now bearing the whole cost, that the use of the canal be made free to the whole world.

General Chittenden's paper was followed by a brief one by Major J. J. Morrow, of Portland, Ore., which dealt with

Oregon conditions. South of Portland the mountains are too close to the ocean to give room for either railways or ports and the ocean near the coast is most treacherous. The paper dealt chiefly with the riprap jetties constructed some years ago at the mouth of the Columbia and since used with equal success elsewhere. Approving mention was made of the new spirit which has pervaded harbor work on the Pacific Coast, giving rise to state and local funds to supplement federal appropriations.

At a subsequent session, F. C. Finkle, of Los Angeles, referring to Gen. Chittenden's remarks on the artificial character of the port of Los Angeles, urged that while the port is artificial, it will be adequate to accommodate the large vessels of the day and that its very artificiality, combined with its closeness to the open sea, will make costly pilotage unnecessary. Mr. Finkle also mentioned the municipal railway and the line of freight automobiles which will connect inland Los Angeles with the port.

THE LOS ANGELES AQUEDUCT — An illustrated talk on this remarkable engineering work was given by its chief engineer, Wm. Mulholland. Most of our readers are already acquainted with the main features of this aqueduct, which will convey Owens River water for many scores of miles from the Sierras to Los Angeles, furnish a water supply to meet the needs of this city of marvelous growth for years to come, and at the same time develop some 70,000 hp. The river drains the slopes of 13 mountains over 13,000 f. in height. Its minimum flow is 30% of the maximum, compared with 7 to 10% in some of the streams near-by.

The aqueduct construction is now 92% completed. The storage dam near Owens Lake is also nearly done. Many miles of the concrete-lined aqueduct have been filled with water and proved to be practically free from leakage.

The close attention given to Mr. Mulholland's talk and the numerous questions put to him bore deserved tribute to both the work and the man.

This talk was given on Wednesday evening. By request it was followed by a repetition, with variations, of the illustrated talk on Mt. Rainier given the night before by Asahel Curtis. The illustrated talk on Alaska, already mentioned, was by Maurice D. Leehey, mining lawyer, of Seattle and Alaska.

IRRIGATION—Two papers on irrigation were scheduled for the final session on Thursday, one an illustrated talk by F. H. Newell, Director U. S. Reclamation Service, and the other by E. G. Hopson, Supervising Engineer, U. S. Reclamation Service, Portland, Ore. Mr. Newell was unable to be present. Mr. Hopson's paper, which was illustrated by lantern slides, was entitled, "Economies in Water and Design of Works, Possible by Avoidance of Excessive Seepage Losses." Figures and diagrams were presented showing by years the losses from seepage and from evaporation in four large storage reservoirs in California and Oregon. The evaporation, which is, of course, uncontrollable, ranged from 6% upward to some quite high figures. Seepage losses have run from 6 to 60% and over, the heavy losses, of course, being due to poor reservoir bottoms and being temporary. The obvious lesson drawn from the heavy reservoir seepage losses is that great care should be taken in the selection of reservoir sites.

From one-fourth to one-half of the available water supply is lost in reservoirs and canals together up to the beginning of the farmers' ditches. The loss in these ditches is sometimes very heavy.

The advantages of lining canals and ditches were explained. Lining not only results in cutting seepage losses down to 10%, but it also reduces the necessary size of canals and cuts out special construction for drops, thus often saving large sums in the aggregate. In general, the cost of ditch lining does not increase the total cost of irrigation works more than $10 an acre on the average; sometimes not over $5.

The merits of pipes for conveying irrigation water were also discussed by Mr. Hopson. Many miles of reinforced concrete pipe, 54 to 12 in. in diameter, have been used by the Reclamation Service, some under as high a head as 110 ft. The results have been uniformly satisfactory. The seepage losses are almost negligible, even when the pipe is under a head of 50 ft.

The average cost of six irrigation projects has been $55 per acre. The loss of water under these projects is perhaps 50%, of which 8% is incurable, while the remainder could be reduced 90% by lining the canals and ditches. The author expressed the belief that more lining would be used in the future than in the past.

The importance of the drainage problem was touched upon. Hundreds of thousands of dollars have been spent in connection with some of the irrigation projects. In the future, state legislatures may have to make the lining of canals compulsory in order to reduce seepage losses and lessen drainage problems.

A voluntary paper on "State and National Water Loss" was presented by John L. Lewis, State Engineer of Oregon (Salem, Ore.). The essence of the paper was the necessity for federal administrative control of water rights. This was deemed necessary both because of the interstate character of many streams and of the diverse and sometimes conflicting uses to which streams are put. In conclusion, Mr. Lewis urged that engineers in the future, more than they have in the past, devote themselves to the determination of stream control policies instead of leaving this almost wholly to the lawyers.

BUSINESS SESSION

Two hours on Wednesday morning were devoted to business. Most of the time was occupied with the consideration, amendment and adoption for reference to the members for action by ballot of a proposed amendment of Article VII of the Society, on the nomination and election of members. The formal amendment submitted to the meeting virtually as the sense of the Board of Direction was amended at the unanimous suggestion of the expiring nominating committee (or rather the five members present out of a total of nineteen). The principal changes finally included in the amendment were as follows:

Eight of 19 members of the nomination committee will constitute a quorum, while at present no quorum is stipulated. At present, the nominating committee must meet at the convention. The amendment offered by the nominating committee, and adopted, permits the committee to select its time and place of meeting. By this means and by keeping the quorum down to eight instead of the ten favored by the Board of Direction, there is far less likelihood than under the amendment as officially presented, that the nomination of officers will be thrown into the hands of the Board of Direction by default.

The secretary stated the case in favor of a quorum of ten, but was met by the argument that eight is a majority of the fourteen elected members and that the five living past presidents rarely attend the meetings of the nominating committee, none being present this year. It was also urged that on the Board of Direction five members (of 30) make a quorum. A motion to adhere to the official provision of ten members for a quorum of the nominating committee was voted down.

Another change, included in the original or official amendment, and approved by the meeting, increases the number of signatures required for opposition nominations from 10 to 25, and requires the printing on the ballot of the names of the signers for the opposing nominations. The names of the members of the nomination committee who sign the report must also appear on the ballot.

A resolution was adopted requesting the Board of Direction to pay the traveling expenses of the nominating committee. The Board already has this power, and its members are paid their traveling expenses for attendance at Board meetings.

The usual formal call of Committees brought out no reports.

A summary of preference votes by members for place and time of holding the 1913 convention showed an original vote of 74 for Washington, D. C.; 40 for

Boston, 30 for Saratoga, and scattering votes for dozens of places, making a total of 425. There have since been received, too late for checking against the original vote for duplicates, 345 printed cards favoring Nashville, Tenn. The votes on time of meeting seemed to have little significance.

On the question of forming a committee to report on the condition of engineers, and on the establishment of an employment bureau by the Society, referred to the Board at the annual meeting in January, the Board reported that in its opinion it would not be wise to establish an employment bureau, but that an investigation of the conditions of employment and compensation of engineers is desirable. The Board recommended that the matter in hand be referred back to it, with instructions for the appointment of a committee to investigate the conditions and compensation of engineers and that only. This recommendation was adopted without discussion.

As a final word on the convention as a whole, it may be said that it was eminently successful. Although, as noted at the beginning of this report, the attendance of members was small, considering the large total membership, yet altogether about 400 persons were registered. Included among the 250 guests were many engineers of the Northwest and particularly of Seattle and vicinity, whose presence and profitable experience at the convention seem likely to lead them to become members.

Annual Convention of the American Institute of Electrical Engineers

The twenty-ninth annual convention of the American Institute of Electrical Engineers was held at the Hotel Somerset, Boston, Mass., June 24-28. This is the second such meeting in recent years to be held in a metropolitan center instead of a summer resort, as customary. The attendance, of course, was larger (over 900 compared with 200-300), but this gain was secured at the expense of comfort and of lessened personal contact between the various members who were scattered around various hotels. One feature of this convention was the simultaneous sessions with the Society for the Promotion of Engineering Education and of the Illuminating Engineering Society.

Another feature of the convention was the presentation of the Edison medal for meritorious achievement to George Westinghouse, at a banquet of the Institute.

The entertainment program included an opening reception, a concert, theater party and trips to Harvard University, Massachusetts Institute of Technology, and various power stations.

The convention program was very greatly overloaded; the first expedient being to group the papers of similar interest and present them in parallel sessions. The second expedient was to cut down the time allowed for abstracting and discussion. This led to very meager comments and aroused vigorous protest from the members.

President's Address

In the presidential address on "The Relation of Electrical Engineering to Modern Life," President Gano Dunn argued that the important and permanent characteristics of all engineering were its methods of applying scientific knowledge to utilitarian action. His contention was that science was barren and introspective until the era of engineering came, when it was turned to benefiting life. What was true in general about all engineering he held to be particularly true of electrical engineering, since it touched other branches and all life at so many points. He believed also that the many highly specialized types of engineers — "efficiency," "industrial," "agricultural," "social," etc.—would disappear as the "engineering method" became a fixed part of the work of managers, farmers, manufacturers, etc., while only the broader distinctions would persist as at present.

Power Transmission

One session was called the "high-tension transmission" meeting and at it four papers on experimental work were presented. In "Determination of Corona Losses at High Potential," Prof. C. F. Harding, of Purdue University, described work with a 1380-ft. experimental line to check up other earlier expressions for this direct loss from wire to wire through air. He noted accuracy of formulas above visual critical voltages and greater losses below.

F. W. Peck, Jr., of Schenectady, in "Law of Corona, II," published a full account of studies which led him to believe that this loss started as conduction from positive to negative wires—always starting from positive and so starting alternately at each half cycle from alternate conductors.

Prof. J. B. Whitehead, of Johns Hopkins University, Baltimore, contributed his third paper on this subject, "The Electric Strength of Air, III." His result seemed to confirm Mr. Peck's conclusions; he found also that dividing a circular conductor into three equal symmetrically placed omes raised the critical voltage 16%; four wires raised this point 20%.

Prof. A. E. Kennelly and F. W. Lieberknecht, of Harvard University, in "Measurements of Voltage and Current over a Long Artificial Power-Transmission Line," described the construction and use of laboratory apparatus constituting a model line having the electrical properties of actual lines of up to 500 miles long for three-phase and 1500 miles single-phase.

Electrochemistry and Physics

While the foregoing papers were being read, several others on electrochemistry and electrophysics were being presented in a parallel session. In "Electrolytic Corrosion of Iron in Street Soils," Prof. A. F. Ganz, of Stevens Institute of Technology, described tests of (1) wrought-iron, (2) steel, (3) ingot-iron and (4) cast-iron pipes, each buried in two typical kinds of soil and subject to direct current from pipe to soil. He found that the corrosion was always as great as expected from Faraday's loss of electrolysis and often greater, even subtracting all possible corrections. In the discussion, it was reported that others also had noted this phenomenon and had offered the "explanation" that the forced electrolytic corrosion due to impressed currents stimulated the natural corrosion which would be obtained by burying the pipe without outside current.

In "The Electric Furnace," F. A. J. Fitzgerald, of Niagara Falls, described the early development of arc, induction and resistance furnaces, noted the trend of design and pointed out some present problems, limitations and possibilities.

Carl Hering, of Philadelphia, in "Simplification of Electro-Thermal Calculations," again asked for the use of the watt as the unit of energy whether existent in heat or electrical form. He also presented thermal conversion factors for changing old data to a form which allowed use of the simple formula (after Ohm's law), "flow of heat energy equals drop in temperature divided by thermal resistance."

W. R. Whitney, of Schenectady, in "Vacuo," described various experiments made in studying the phenomena resulting in incandescent lamps by increasing their initial degree of vacuum. The paper, "Metallic Tungsten and Some Applications," by W. D. Coolidge, of Schenectady, is well described by the title.

According to the paper, "Convection and Conduction of Heat in Gases," by Irving Langmuir, of Schenectady, convection consists essentially of the effect of conduction through a film of definite thickness with negligible carriage by movement of the envelope. The thickness for quiet air at room temperature and atmospheric pressure is 0.43 mm. and varies inversely as the 0.75th power both of the pressure and of wind velocity.

Electric Lighting

At the joint session with the Illuminating Engineering Society, C. E. Clewell, of Pittsburgh, read the paper, "Industrial Illumination and Average Performance of Lighting Systems." In it he briefly mentioned some of the points which have to be carefully considered in shop lighting—re-direction from lamps, height and spacing, and then passed on to show the results of tests on five typical factory

installations, to find the average efficiency (ratio of light received on a working plane to total flux emitted) and various conditions, (1) new tungsten lamps and glass reflectors, (2) clean old lamps and reflectors, (3) clean old lamps and dirty reflectors, and (4) both lamps and reflectors dirty. The initial efficiency was found to vary from 31 to 39% and gradually lowered to from 19 to 25% under the unfavorable considerations noted. The paper contained diagrams to show the computation of economic cleaning periods, supposing that a given amount of light had to be secured either by cleaning or using more lights with dirty globes. It was stated also that the daily cost of both meager and adequate shop lighting had been found to be on an average about equivalent to six months' wages, so that the various gains in good lighting very greatly outweighed the cost.

Basset Jones, Jr., of New York City, presented the paper, "Problems of Interior Illumination," by title and gave an experimental demonstration of the points under discussion. He called any lighting arrangement "efficient" when the light falling on walls, ceiling and furnishings served to produce the effects desired by the architect while, at the same time, the utilitarian service for work etc., was maintained or improved. The author paid particular attention to the effect of various lighting in setting off or submerging the details of relief design by play of light and shadows, and also to the accentuation of prominent features by pigments under colored lights. The architectural and utilitarian uses of light he had found usually required different arrangements which in some way had to be harmonized.

Louis Bell, of Boston, presented a paper, "The Relations of Electrical and Illuminating Engineering," in which he held that the principles of illumination and photometry had been formulated before electric lighting had risen and that the theory and practice of good lighting would continue the same if electricity were taken away—or gas or oil supplies for that matter. Illuminating engineers took the finished product of the electrical engineers as their raw material.

H. E. Ives, of Cleveland, presented the paper, "Relations of Color to Illumination," and gave a demonstration of the different appearance of colored objects under white light with a continuous spectrum and white light made by the combination of three single wave lengths.

Railways

One session was held under the auspices of the Electric Railway Committee of the Institute. In opening the meeting, the Chairman, F. J. Sprague, of New York, explained the apparent lack of activity of the committee during the year by its desire to watch the operation of the direct-current, three-phase and single-phase installations without prolonging past discussions of their merits. It had secured, instead, a paper from Samuel Insull, of Chicago, on power costs which had been presented at one of the New York meetings and was here represented, somewhat revised, under the title, "Relation of Central Station Generation to Railway Electrification."

This paper argues along two lines, which may be summarized as follows:

The system (of electrification) finally decided upon must be the one which fills conditions of (steam) railway demand and at the same time renders it possible for the railway company to take advantage of the sources of energy supply already existing, as the railway demand for energy is only about 15 to 20% of the total demand in any community.

The concentration of production of energy, for all purposes required in a given area about any large center of population, would result in such a saving in capital and in operating expenses as to provide sufficiently for the generating capacity and primary transmission systems necessary to electrify the terminal systems and suburban service of all trunk lines centering in and around that center of population, and such a saving as to yield very large profits, in addition, to the engineers and financiers having the courage to handle so great a problem.

Many of the discussers of this paper thought that Mr. Insull argued for a single mammoth station; but Mr. Sprague explained, in Mr. Insull's absence, that what was meant rather was concentrated management with large stations where local conditions demanded. H. G. Stott, of New York, stated that after railway stations had attained a capacity of 30,000 kw., there was very little economy to be gained from further consolidation. His experience had shown that economy in power production varied as the fourth root of the change in load factor. On this basis the annual saving by consolidating all the power stations in the entire New York and New Jersey metropolitan district would be only $135,000 instead of the $1,000,000 computed by Mr. Insull.

Education

The joint meeting of the Institute and the Society for the Promotion of Engineering Education was given up to a discussion of various features of a report by the Institute's Educational Committee, Prof. J. P. Jackson, Chairman.

This committee felt that enough had been said for the present about higher education compared with the training of industrial workers. The report, therefore, took the form of a study of the vocational and industrial education of the day.

As subdivisions of the report, Prof. H. H. Norris, of Cornell University, and Prof. Samuel Sheldon, of Brooklyn Polytechnic, described particular schools and Prof. W. I. Slichter, of Columbia University, prepared a digest of state laws on vocational education.

As usual the discussion was long and ramified, the expressions generally trending toward the desirability and possibility of coöperation with state and local boards to steer these developments into best channels. Much was said about the details of school administration—whether or not, for instance, existing shops could be utilized for the practical training without having the school duplicate the equipment.

Telephony and Telegraphy

Parallel with the joint session on education, there was one on telegraphy and telephony, at which the following papers were read: (1) "History of Submarine Signaling," by H. J. W. Fay, of New York; "Wiring Large Buildings for Telephone Service," by F. L. Rhodes, of New York; "Vibrations of Telephone Diaphragms," by C. F. Meyer and J. B. Whitehead, of Baltimore; and (by title) "Military Telegraph Lines Using the Polarized Sounder as Receiver," by Lieut. G. R. Guild, Signal Corps, U. S. A.

Electric Power

The fourteen papers on the two sessions on power stations and industrial power made two fair-sized volumes. On account of the haste necessary to wade through such a program most of the little discussion possible was very superficial.

In "The Squirrel Cage Induction Generator," H. M. Hobart and E. Knowlton, of Schenectady, set forth limitations to the use of these "driven induction motors" and described features of mechanical design that made them desirable as steam-turbine units.

In "Power Efficiency of Rotating Electrical Machines," E. M. Olin, of Pittsburgh, argued for the computation of full-load efficiency of large machines by "summation-of-loss" methods based on various no-load tests corrected for the effect of load. He claimed a greater accuracy than possible by direct input-output tests under the actual conditions imposed.

"Operating Characteristics of Large Turbo Alternators," by A. B. Field, of Cincinnati, was a review of features secured in various designs, here and abroad, compared with earlier work, and with further changes which might be desirable.

P. M. Lincoln, of Pittsburgh, in "Motor-Starting Currents As Affecting Large Transmission Systems," described a rough investigation of the conditions which were leading many companies to avoid very large single-motor and single-shop installations, through fear of (1) endangering too much income by loss of a single motor, (2) voltage fluctuations from starting currents, (3) inability to

start many large motors at once. By studying the load and current fluctuations in several installations, he found surprisingly little additive disturbance from the different motors and concluded that the only logical restriction was to keep the largest motor below 25% of the largest mill capacity on the line.

B. G. Lamme, of Pittsburgh, presented "Development of a Successful Direct-Current 2000-kw. Unipolar Generator," which was an unusually interesting account of the various operating problems which had been met and overcome by a generator of unusual design—a direct-current machine with one pole and no commutator, giving 7700 amp. at 260 volts.

"Single-Phase Induction Motors," by W. J. Bronson, of Pittsburgh, gave a graphical method of design computations of sufficient accuracy to serve under the exacting conditions of very small motors.

D. B. Rushmore, of Schenectady, contributed a descriptive paper entitled "Excitation of Alternating-Current Generators."

The paper, "Transient Reactions of Alternators," by W. A. Durgin and R. H. Whitehead, of Schenectady, showed that the first rush of short-circuit current found in large alternators did not rise to the values expected from customary calculations. This was accounted for by "transient impedence" which was caused by the suddenness of the first rushes—something which had not been, but could be, taken into account.

Prof. D. W. Mead, of Madison, Wis., in "Runaway Speed of Water-Wheels and the Effect on Connected Rotary Machinery," reviewed the design of hydraulic impulse wheels and turbines to find the limits of runaway speed. He found that the over speed to be cared for with constant high-head impulse units was 100% and 50 to 80% with reaction units built for constant head. The latter, however, when designed for varying head may develop 100% overspeed and more.

"Localizers, Suppressors and Experiments," by E. E. F. Creighton, of Schenectady, and J. T. Whittlesey, of Newark, N. J., described the use of devices on the underground high-tension lines of the Public Service Electric Co., to suppress arcs to ground and to indicate the line in trouble (noted in ENGINEERING NEWS, Feb. 23, 1911, p. 242).

L. L. Elden, of Boston, in "Relay Protective Systems," described useful modifications of the Merz-Price schemes seen in England for the protection of alternating-current networks. In this, switch-opening relays were tripped by current flowing between opposed transformers at the ends of a feeder, when more flowed into it than came out, as in case of defects.

There were also three papers descriptive of power installations: (1) "Application of Electric Drive to Paper Machinery," by E. C. Morse, of Dorchester, Mass.; (2) "Electric Drive for Paper Machines," by J. S. Henderson, Jr., of Boston; (3) "Electricity on the Farm," by P. S. Bates, of New York.

ELECTRICAL MEASUREMENTS

Parallel with the power sessions, were two sessions on electrical measurements with equally long programs:

"Measuring Stray Currents in Underground Pipes," by Carl Hering, of Philadelphia.

"Electrical Transmission of Electrical Measurements," by O. J. Bliss.

"Metering Large Direct-Current Installations," by F. V. Magalhaes, of New York.

"A Tubular Electrodynamometer for Heavy Currents," by P. G. Agnew, of Washington, D. C.

"Measurement of Alternating Current of Low Value," by M. G. Newman, of Pittsfield.

"Electrical Measurements with Special Reference to Lamp Testing," by E. J. Edwards, of Cleveland.

"To Measure an Alternating-Current Resistance and Compare it with the Direct-Current Resistance," by E. F. Northrup, of Philadelphia.

"Measurement of Energy with Instrument Transformers," by Alexander Maxwell, of New York.

"Compensating Wattmeters," by A. L. Ellis.

"Potential Transformer Testing," by J. R. Craighead, of Schenectady.

"Measuring Permeability with Alternating Current," by L. T. Robinson and J. D. Ball.

"Measuring Maximum Values in High Voltage Testing," by C. H. Sharp and F. M. Farmer, of New York.

"Hot-Wire Instruments," by A. W. Pierce and M. E. Tressler, of Pittsfield, Mass.

"Incandescent Lamps as Resistances," by T. H. Amrine, of Harrison, N. J.

"Resonant Circuit-Frequency Indicator," by W. H. Pratt and D. R. Price, of Lynn, Mass.

"Wheatstone Bridge Rotating Standard Method of Testing Large Capacity Watt-Hour Meters," by C. H. Ingalls and J. W. Cowles, of Boston.

"Testing Instrument Transformers," by P. G. Agnew and F. B. Silsbee, of Washington, D. C.

"A New Power Unit," by H. G. Stott, of New York.

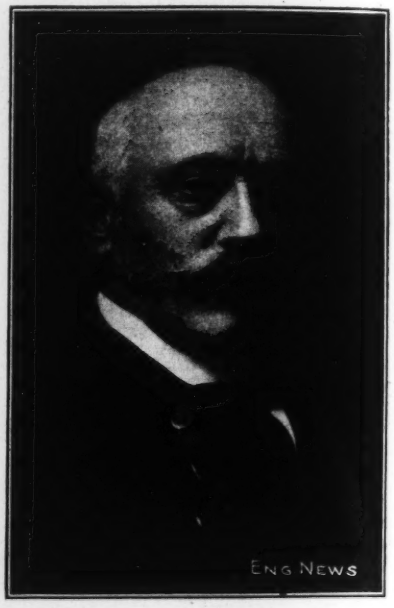
In the last-named paper Mr. Stott stated that he had found that one boiler-horsepower was within 2% of 10 kw.; he therefore proposed, as a unit of rate of energy supply to a boiler, the "Myrawatt" (or 10 kw.). One desirable feature was that a modern plant, of ordinary efficiency, for each myrawatt fuel input would yield one kilowatt at the switchboard.

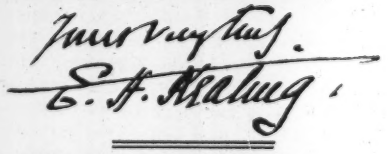
The Department of Public Works of British Columbia is spending $8,500,000 for roads, bridges and other improvements. Some of the new roads are located 1200 to 1500 miles north of Vancouver. J. E. Griffith, known in the Canadian west as the man who walked from Winnipeg to Vancouver while making Canadian Pacific location surveys, in the 80's, is chief engineer of British Columbia.

Edward Henry Keating

Owing to unavoidable delay in receiving a photograph of the late Edward Henry Keating we were unable to publish the accompanying portrait in our issue of last week.

Besides accomplishing notable engineering undertakings, Mr. Keating also contributed much to the general store of engineering knowledge and experience, both as a contributor to the *Transactions* of the Institution of Civil Engineers and those of the Canadian Society of Civil Engineers, and as the author of numerous government reports on public works.





Notes from Engineering Schools

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Theodore N. Vail, President of the American Telephone & Telegraph Co., of New York City, has presented the Institute with a very valuable collection of books on electricity, which added to the Institute's present library will make it one of the most complete of any in the world on electrical engineering. The present donation is the collection of the late George Edward Dering who died in England in January, 1911. Mr. Dering was more than 40 years in accumulating his library, which was the chief hobby of his life. The collection also contains many works on iron and steel. Mr. Vail is not a graduate of the Institute and has no connection with it save as an employer of its graduates. His gift is accompanied by a substantial maintenance fund.

UNIVERSITY OF GEORGIA—The School of Civil Engineering is undertaking to co-operate with the country towns of Georgia in connection with improved road construction. Besides special courses on road and bridge building, giving advice by correspondence on road matters and publishing road bulletins, the University undertakes laboratory examinations of road material, and on request will make visits and give advice with reference to road improvement problems, improving dangerous railroad crossings, road drainage, culverts, etc. In Hart County, Georgia, the roads are being surfaced with top soil. Fields are purchased from farmers adjacent to the road with the privilege of removing the top soil to a depth of 12 in. These soils are a fairly well mixed and uniform mass of gravel, sand and clay. They are spread upon the road to a depth of 10 in., to a width of 16 ft. The cost of this surfacing, being convict labor, is said to average $500 per mile. The chief advantage of the top soil appears to be that the sand, gravel and clay have become well mixed by years of cultivation.

A Wind Storm, at Regina, Sask., June 30, is reported to have killed 50 people. On July 1, 36 bodies had been taken from the ruins. The property loss is estimated at $1,000,000. The telephone exchange and a number of business blocks were demolished besides many residences. The city-lighting system was put out of operation by the breaking of wires.

A French Naval Accident, June 26, caused the death of one officer and three men and the injury of a number of others. The accident was due to the premature discharge of a 6-in. gun on the cruiser "Jules Michelet," off Hyeres Islands. Two explosions occurred, the firing being resumed after the first accident only to be followed by a second explosion about three hours later. Reports state that the accidents were both due to ignition of the charge while being loaded.

Another Zeppelin Dirigible Wreck, June 28, destroyed the "Schweben," the sister ship of the "Victoria Louise," which completed a flight over the North Sea carrying 12 passengers only the day before. Thirty-four soldiers were badly injured. Reports state that the "Schweben" was anchored near the Düsseldorf balloon shed when it was torn from its moorings by a gust of wind and the gas bag was broken. The soldiers were injured by an explosion of the escaping gas.

Accident to the Dredge "Corozal"—The main driving-wheel gear on the port side of the new Panama Canal ladder dredge "Corozal" (described in Engineering News of Jan. 25, 1912), broke on June 4, putting the dredge out of commission until a new wheel can be installed. The accident occurred while the dredge was excavating in a 25-ft. bank, the upper part of which consisted of stratified clay, and the lower part of argillaceous sandstone, and resulted in breaking off every one of the spokes of the port gear wheel, leaving the hub entirely free. The gears are 14½ ft. in diameter, 2 ft. wide, and made in two sections, an outer wheel or cog rim, and an inner wheel consisting of rim, spokes and hub, each section weighing approximately 10 tons. Considerable difficulty was experienced in handling the broken parts owing to their great weights. The accident is the first of its kind to happen to one of the Panama Canal dredges, although a similar break occurred on one of the dredges used to build the Suez Canal. A new casting has been made at the Gorgona shops, machined at Empire, and was ready for shipment on June 17. Another casting has also been ordered from the Scotch builders.—"Canal Record."

Fires Caused by Lightning in the State of Wisconsin caused damage amounting to $150,000 in the single month of May. According to a report of the state fire marshal, 56 out of a total of 239 fires originated from lightning. In Minnesota during the past year, 145 fires were caused by lightning, but in not one case reported was a building properly protected by lightning rods.

Canadian Duties on Cement will be reduced during the period between June 12 and Oct. 31, 1912. On account of a serious shortage of cement in Canada, the Government has reduced by about one-half the duty on cement and lime in barrels, bags, or casks. The duty on these articles has been 52c. per bbl. of 350 lb. During the period noted it will be 26c. on importations from the United States, 17c. on those from Great Britain, and 23c. on those from Belgium.

A Physical Valuation of all the property of the Chicago, Burlington & Quincy R.R. is to be made within the next two years, according to a report from Chicago on June 27. A valuation of the railway's property in Nebraska has already been completed and that in Iowa is at present being appraised.

The New York Subway Plan is Legal in spite of its provisions for preferential payments to the operating companies, so the highest court of New York state has decided. The question turned on the constitutional provision that a city may not lend its money or credit to private parties. The majority (4) of the Court of Appeals holds that it is not contrary to this provision for the city to take its rental from the operating company by sharing in income after first providing for 6% payment to the company. The minority (2) held that in the proposed contracts, by guaranteeing a certain income to the companies in the sense of permitting this income to be paid out of net proceeds before the city's share of income is paid, the city does in fact lend its credit to the operating companies. The contracts will now be made ready for final approval by the authorities.

The Gatun Dam Sluice-Gates had to be opened, on June 5, to prevent the level of Gatun Lake, Panama Canal, from rising higher than an elevation of 28 ft. above sea level. The work of placing the steel sills for the floating caisson dams in the upper approach to the locks had not been completed, and it was necessary to open the sluice-gates to prevent the work from being submerged. The gates will be closed again as soon as possible.

The opening of the sluice-gates caused the appearance at the lower end of the lake of a number of floating islands. These are masses of decayed vegetation and fallen trees, held together by the roots of a dense overgrowth of swamp plants; some are 300 ft. long and 200 ft. wide, and generally are of sufficient solidity to support a man in walking over them. They appear to have formed in the Black swamp and to have been loosened by the 10-ft. rise of the lake since Apr. 30, when the gates were closed; and the current caused by opening the gates brought them toward the dam.

The Australian Capital Competition, the first prize in which was awarded to Walter Burley Griffin, of Chicago, as described fully on page 20 of this issue, resulted in a divided vote by the judges of the various designs. Recent advices from Australia give the following list of awards:

Majority Report (2 out of the 3 judges) judges)

1st prize (£1750): Walter Burley Griffin, Chicago, Ill.

2d prize (£750): Eliel Saarinen, Helsingfors, Finland.

3d prize (£500): Alfred Agache, Paris, France.

Honorable Mention: H. Van B. Magonigle, New York City. Schanfelberg, Rees & Gummer, London, Eng.

The minority report of one judge, for which no awards were made, was as follows:

1st prize: Griffiths, Coulter & Caswell, Sydney, Australia.

2d prize: A. C. Comey, Cambridge, Mass.

3d prize: Nils Geilerstedt, Stockholm, Sweden.

The majority judges were J. Alex. Smith, representing the engineers, and J. Kirkpatrick, representing the architects; and the minority judge was J. M. Coane, representing the surveyors.

It is stated that the first design would not necessarily be adopted as that for the building of the city, but that the government would probably make its own design from the prize-winning designs, which are now the property of the government.

The Dirigible Balloon "Akron" Was wrecked, July 2, by the bursting of its gas bag while sailing at a height of about 1000 ft. Melvin Vaniman, the commander, and his crew of four men were killed. The accident occurred at 6:38 a.m., during a trial trip at Atlantic City, N. J. Reports state that the gas bag appeared to break in two, after which there was a terrific explosion. The wrecked airship with its crew fell into 18 ft. of water in Absecon Inlet.

Melvin Vaniman, after accompanying Walter Wellman in his unsuccessful attempt to cross the Atlantic in a dirigible, has been engaged in preparing for another attempt to be made under his own direction. His balloon, the "Akron," had a gas bag 258 ft. long, with a diameter of 47 ft. It has been stated that the envelope was to be made of a special fabric strong enough to resist the expansive force of the gas when heated by the sun.

Municipal Improvements, at Vancouver, B. C., either under way or projected, include 30 miles of water mains, 30 to 35 miles of sewers, 50 miles of sidewalks and about 500,000 sq.yd. of pavements, besides additions to the water supply and heavy sewer work. In 1911 there were laid 24 miles of water mains, 27 miles of sewers (5 ft. in diameter, down), 11½ miles of pavements and 41 miles of sidewalks. The population of Vancouver is conservatively estimated as 112,000.

Of the new pavements, 265,000 yd. will be of asphalt concrete, laid by the Canadian Mineral Rubber Co., of Chicago; 235,000 yd. of creosoted fir blocks, laid by the M. P. Colton Co., and 15,000 yd. of bitulithic.

An extensive trunk and intercepting sewer system has been planned and portions are under construction. This will divert the dry-weather flow from an inlet known as False Creek to deeper and more open water. An area of 90 sq.mi. is involved, but this includes adjoining municipalities. Two 10-ft. sewers are under construction and work has been started on a third sewer, a portion of which may be 10x17 ft. in section. All three of these large sewers are of reinforced concrete. R. S. Lee, of Montreal, is consulting engineer for Vancouver on this large sewer work, and Donald Cameron, of Cleveland & Cameron (Vancouver), is consulting engineer for one or more of the other cooperating cities. (Mr. Cameron will be remembered by many of our readers as formerly City Engineer of Exeter, England, and father of the septic tank).

A 30-in. steel water-supply main is being built to bring in a large addition to the water supply of Vancouver and a 24-in. main is being laid from the present source of supply to the city, for the joint supply of Vancouver and the city of Point Grey. The existing supply works have a daily capacity of about 18,000,000 Imp. gal. One of the new mains will be jointed on shore and pulled across Burrard Inlet, in the general manner described in our issue of Apr. 1, 1909. H. M. Burrell, of Vancouver, is consulting engineer for the new water supply. F. L. Fellowes is City Engineer of Vancouver, having left a similar position at Westmount (Montreal), Que., early in 1911, to go to Vancouver.

Personals

Dr. Elmer P. Kohler, recently Professor of chemistry at Bryn Mawr College, has been appointed Professor of chemistry at Harvard University.

Mr. F. B. Marble, formerly Division Engineer of the Michigan Central R.R., at Detroit, Mich., has been promoted to be Assistant to Chief Engineer G. H. Webb, M. Am. Soc. C. E.

Mr. A. T. Palmer, Assistant Superintendent of the Southern Pacific Ry., at Kansas City, Mo., has retired after 36 years of railway service to engage in farming near Wamego, Kan.

Mr. James Knox Taylor, recently Supervising Architect of the United States Treasury Department, has joined the faculty of architecture at the Massachusetts Institute of Technology.

Dr. Reginald A. Daly, recently Professor of physical geology at the Massachusetts Institute of Technology, has been appointed Strugis-Hooper Professor of geology at Harvard University.

Mr. William M. Duncan has been appointed Receiver for the Wheeling & Lake Erie R.R., succeeding Mr. B. A. Worthington, whose election to the presidency of the Chicago & Alton R.R. was noted in our issue of last week.

Mr. William J. Zartmann, formerly Superintendent of Parks, Borough of Brooklyn, New York City, has been appointed Principal Assistant Engineer of the department of parks of the Borough of Queens, in charge of construction.

Mr. M. Cabrera has been appointed Resident Engineer of the Tehuantepec National Ry. of Mexico, succeeding to the duties of Mr. H. L. Cummings, Chief Engineer, who has resigned. Mr. Cabrera's headquarters will be at Rinon Antonio, Mex.

Mr. J. R. Gould, Superintendent of Motive Power of the Chesapeake & Ohio Ry., at Richmond, Va., has been promoted to be General Superintendent of Motive Power, succeeding Mr. J. F. Walsh, resigned, as noted in our issue of last week.

Mr. Gilbert H. Pearsall, Assoc. Am. Soc. M. E., General Manager of Sales of Jos. T. Ryerson & Son, 30 Church St., New York City, has been made a Vice-President of the Jacobs-Shupert U. S. Firebox Co. He will retain his present position and his present address.

Prof. H. S. Philbrick, M. Am. Soc. M. E., formerly Assistant Professor of mechanical engineering at the University of Missouri, has been appointed Professor of mechanical engineering at Northwestern University, Evanston, Ill. Prof. Philbrick is a graduate of Colby College in Maine and of the Massachusetts Institute of Technology, class of 1906.

Mr. Charles B. Moore, formerly Vice-President of the American Arch Co., of New York City, and inventor of a number of locomotive devices, has been elected a Vice-President of the Jacobs-Shupert U. S. Firebox Co., of Coatesville, Penn. Mr. Moore will have charge of the western offices of the company in the Railway Exchange Bldg., Chicago, Ill.

Mr. E. R. Lewis, formerly Division Engineer of the Michigan Central R.R., at Bay City, Mich., has been appointed Chief Engineer of the Duluth, South Shore & Atlantic R.R., with headquarters at Marquette, Mich. Mr. J. C. Bebb, also of the engineering department of the Michigan Central R.R., has been appointed Assistant to Chief Engineer Lewis.

Sir Maurice Fitzmaurice, M. Inst. C. E., has resigned as Chief Engineer of the London County Council to be able to devote all his time to private practice. A short biographical sketch of Sir Maurice was given in our personal columns on Mar. 28, 1912, at the time he was knighted by King George IV. To have been for several years City Engineer of the world's greatest city is a distinction which can come to but few men, but aside from his municipal work, Sir Maurice has attained an international reputation as a consulting engineer on a great variety of engineering subjects. He is a member of the council of the Institution of Civil Engineers, a member of the Institution of Mechanical Engineers, the Canadian Society of Civil Engineers and an honorary fellow of the Society of Engineers. He is also the author of several books, reports and professional papers, including "Plate-Girder Railway Bridges," "Shrinkage of the Thames and Lea," "London County Bridges," "The Main Drainage of London," and many others. He is 51 years old, and began his engineering career as an apprentice of the late Sir Benjamin Baker, one of the builders of the Firth of Forth Bridge.

Obituary

W. K. High, former Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis R.R., at Mattoon, Ill., died, June 21, at his home in Mattoon.

Cecil Brunswick Smith, M. Am. Soc. C. E., senior member of the firm of Smith, Kerry & Chase, of Toronto, Ont., died at his home in Toronto, from cancer on July 1. A biographical sketch of Mr. Smith will appear in a later issue.

Engineering Societies

COMING MEETINGS

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 26-30. Annual convention at Peoria, Ill. Secy., Clarence R. George, Houston, Tex.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. car shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS.
Sept. 2-7. Sixth congress at New York City. Secy. of organiding committee, H. F. J. Porter, 29 West 39th St., New York.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.
Sept. 4 at Washington.
Sept. 6-13 at New York City. Secy., Bernhard C. Hesse, 25 Broad St., New York.

The Ohio Electric Light Association—The program for the 18th annual convention to be held at Cedar Point, Ohio, July 16-19, includes the following papers: "Rate Making," Halford Erickson; "The Public versus the Utility," D. L. Gaskill; "Electrolytic Purification of Sewage," F. C. Caldwell; "Supply of Electric Current to Rural Districts," J. C. Matthieu; "Joint Pole Line Construction," J. L. Spore. In addition, there will be the address of the President, Mr. W. C. Anderson, and the reports of the committees on electrical transmission, costs and meters.

Society of Automobile Engineers—The opening session of the summer meeting was held Thursday morning, June 27, in the Pontchartrain Hotel, Detroit, Mich. After the address of President H. F. Donaldson, routine business was taken up and consumed the remainder of the morning. Thursday afternoon was devoted to visits of inspection to motor-car factories. In the evening the members sailed for Mackinac, returning to Detroit Saturday night. Four closed sessions were held on shipboard on Friday and Saturday. The papers presented were as follows: "Cost of Work with Gasoline Motor Trucks," Lewis Ruprecht; "Method of Brake Capacity Determination," S. I. Fekete; "Leaf Springs," L. J. Lane; "The Standardization Work of the S. A. E.," Henry Souther; "Stability of Automobile Propeller Shafts," J. M. Thomas; "The Effect of the Relation of Stroke and Bore in Automobile Engines," John Wilkinson; "Motor Sizes and Drive Ratios for Commercial Vehicles," Eugene P. Batzell; "Worm and Helical Gears as Applied to Rear Axles," Frank Burgess; "Standardization and Coöperation in Motor Testing," H. L. Connell; "A Comprehensive Motor Test," Herbert Chase.